TIER 2 SITE CLEANUP REPORT GUIDANCE

For Assessing

Leaking Underground Storage Tanks (LUST)

Using Risk-Based Corrective Action (RBCA)

Iowa Department of Natural Resources
Underground Storage Tank Section
Wallace State Office Building
502 East Ninth Street
Des Moines, IA 50319-0034
515/281-8693

Version 1.0 -- November 1996

IMPORTANT: This document, "Tier 2 Site Cleanup Report Guidance (version 1.0 -- November 1996)", is a draft version. Incorporated into this draft guidance are proposed rule changes which were made in response to public comments. Because the rule changes have not received final approval, the content of this document may change. The department anticipates revision of this guidance within the next few months and updated versions will be made available at that time.

TABLE OF CONTENTS

CHAPTER 1: TIER 2 SITE ASSESSMENT OVERVIEW AND GENERAL CONSIDERATIONS

1.1 Tier 2 Site Assessment General Overview

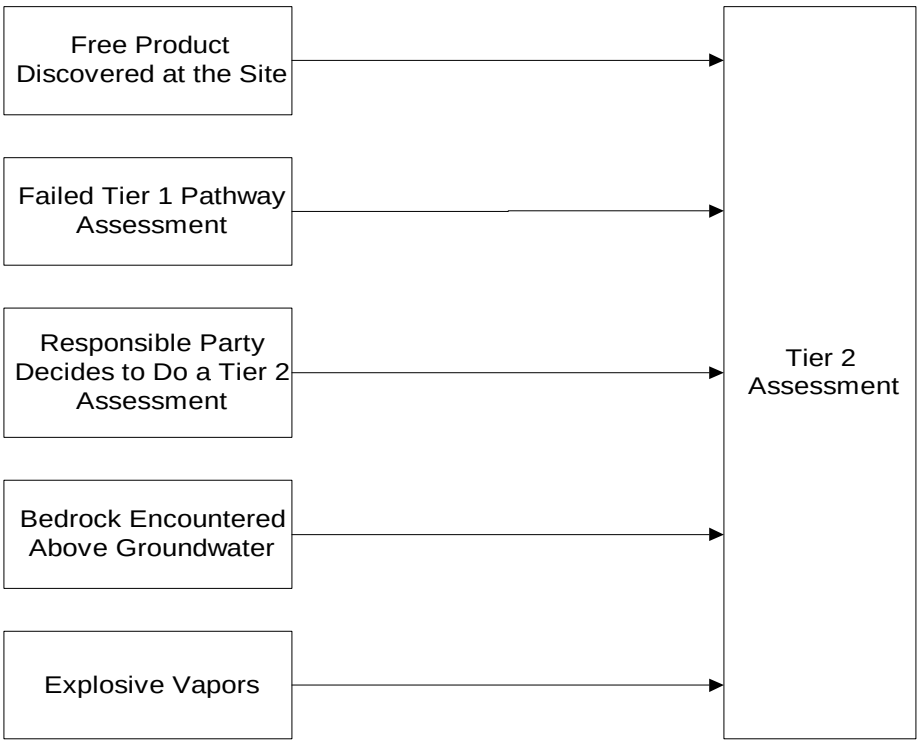
The purpose of this guidance document is to supplement the administrative rules contained in Chapter 567--135, "Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks," of the Iowa Administrative Code. The objective of a Tier 2 assessment is to collect site-specific data and with the use of models, determine what actual or potential receptors could be impacted by the chemicals of concern. The models also provide a method for predicting a source concentration or site-specific target level (SSTL) that would be protective of the receptors.

A Tier 2 site assessment must be conducted and a site cleanup report submitted for all sites when any of the following conditions occur:

- Free phase petroleum product is present at the site.
- The site owner or tank owner/operator has decided to bypass the Tier 1 assessment and go directly to the Tier 2 assessment phase of the project.
- Failed a Tier 1 pathway assessment.
- During drilling, bedrock was encountered before groundwater.
- Explosive vapor levels were measured when?

The following flow chart may be used to determine when a Tier 2 assessment is required.

Flow Chart for Determining When a Tier 2 Assessment is Required



All pathways and chemicals of concern groups must be evaluated when a Tier 2 assessment is being conducted due to the presence of free product, the site is located in an area where bedrock is encountered before groundwater, or the responsible party has elected to go directly to the Tier 2 assessment. The groundwater professional must conduct a Tier 1 site analysis to identify complete pathways prior to conducting the Tier 2 assessment. The Tier 2 assessment then focuses on the complete pathways.

The groundwater professional must refer to the Tier 1 Guidance for instructions on conducting a Tier 1 site assessment. The results of Tier 1 must be recorded in the Tier 2 assessment report.

For sites that have undergone a Tier 1 assessment, the Tier 2 assessment must focus on all the pathways and chemicals of concern groups that have not obtained a no further action clearance. A pathway must be reassessed, if in the course of conducting a Tier 2 assessment, data indicate the conditions for pathway clearance under Tier 1 no longer exist. The groundwater professional must also be knowledgeable of the investigative methods contained in the department's Tier 1 Guidance because the Tier 2 assessment, as noted above, may involve the initial or reevaluation of pathways.

1.2 Computer Hardware and Software Requirements

The Tier 2 data analysis must be conducted using the department's computer software. A 486 Intel 50 MHz processor with 8 MB RAM and 1 GB hard drive, and Windows 3.1 or Windows 95 is needed to run the software. The software which includes programs for conducting both Tier 1 and Tier 2 evaluations can be obtained from the IDNR Records Center at a cost. The department's Tier 2 report form is also available as a Word for Windows document on disk which may be obtained from the IDNR Records Center by calling 515/242-5818. The results of the data analysis must be reported in the department's Site Cleanup Report (SCR) format.

The department anticipates revising the guidance documents and the RBCA software in the near future. All Iowa certified groundwater professionals will be sent updates of both the guidance documents and the software package as they become available. Other interested parties may obtain updated versions of the guidance documents and software by submitting a written request to the IDNR, LUST Coordinator, Wallace Building, Des Moines, IA 50319-0034. The written request must include the name and mailing address of the person making the request.

1.3 Site Classification

The Tier 2 data analysis requires site classification. Individual pathways may be classified as high risk, low risk or no action required. Separate classification criteria may apply to actual and potential receptors for any pathway. A single pathway may have multiple classifications based on actual or potential receptor evaluations. Specific guidance on classifying sites is found in section 5.1. A pathway must meet both the criteria for actual and potential receptors for the pathway to obtain a classification of no action required. Sites may have multiple pathway classifications. For a site to obtain a no action required classification, all pathways must meet the individual pathway criteria for no action required classification. Note, however, all corrective actions necessary to satisfy the criteria for pathway clearance must be conducted prior to submittal of a Tier 2 report which requests such a site classification. The department must be informed if these corrective actions require more than 120 days to complete. All corrective action supporting documentation must be submitted as attachments to the Tier 2 report. Documentation may include any of the following:

- Completed well plugging forms
- Proof of institutional controls (copies of deed restrictions, declaration of restrictive covenants, etc.)
- Copies of notices to the IDNR Water Supply Section
- Copies of notices to county authorities which issue private water supply construction permits

- Copies of notices to public authorities responsible for sanitary sewer installation
- Report of soil excavation activities
- Report of plastic water line replacement or relocation
- Copies of notices to utility companies which supply water to the area of concern

1.4 Budget Approvals

UST owners and operators eligible to receive state funds to cover site investigation expenses must submit the Tier 2 preparation budget (and the Tier 1 preparation budget, if not completed) prior to initiating work at the site to GAB Robins, PO Box 3837, 2600 72nd Street, Suite A, Des Moines, IA 50322, 515/276-8046. Failure to receive budget approval from GAB Robins prior to starting work at the site may result in a loss of state benefit eligibility.

1.5 Laboratory Methods

Laboratories which analyze soil and water samples from releases of petroleum-regulated substances must be certified (under 567 - Chapter 42, Part C) in accordance with 567-135.16(455B). A list of certified laboratories may be obtained from the IDNR by calling 515/242-6492.

Soil and groundwater samples from releases of petroleum-regulated substances must always be analyzed for the presence of benzene, ethylbenzene, toluene, and xylenes. Additionally, if the release is suspected to include any petroleum-regulated substance other than gasoline or gasoline blends, or if the source of the release is unknown, the soil and groundwater samples must be tested for the presence of Total Extractable Hydrocarbons (TEH).

Iowa Method OA-1 (*revision 7/27/93*) shall be used for the analysis of soil and water for high volatile petroleum compounds (i.e., benzene, ethylbenzene, toluene, xylene). Iowa Method OA-2 (*revision 7/27/93*) shall be used for the analysis of soil and water for low- or semi-volatile petroleum compounds (i.e., all grades of diesel fuel, fuel oil, kerosene, oil, and mineral spirits). Copies of Iowa Methods OA-1 and OA-2 are available from IDNR by calling 515/242-6492.

A copy of the chromatograms and associated quantitation reports for the waste oil, diesel, and gasoline standards used by the laboratory to identify and quantify the field samples must be submitted. The laboratory analytical reports must state whether the sample tested matches the laboratory standard for waste oil, diesel or gasoline or that the sample cannot be reliably matched with any of these standards.

1.6 Soil Gas Analysis

The National Institute for Occupational Safety and Health (NIOSH) Method 1501, or a department-approved equivalent method shall be used for the analysis of soil gas and indoor air for benzene and toluene vapors. NIOSH Method 1501 is published in the NIOSH Manual of Analytical Methods, 1994. If an alternative soil gas analytical method is to be used, a proposal must be submitted to the department prior to its use. The proposal must contain a justification for the use of an alternative method and a copy of the method including information on sample preparation, calibration, quality control, equipment and materials used in sample extraction and analysis, and calculations used to determine concentrations of chemicals of concern.

1.7 Quality Control/Quality Assurance Procedures

The quality control/quality assurance (QC/QA) procedures used during the site investigation must be at least as stringent as those contained in IDNR's Leaking Underground Storage Tank Quality Assurance Plan. Copies of IDNR's Leaking Underground Storage Tank Quality Assurance Plan may be obtained by calling 515/242–6492. The

groundwater professional must be able to provide IDNR with copies of the QC/QA plan designed for the site, field notes and chain of custody forms on request.

1.8 Plugging Abandoned Wells And Borings

All abandoned wells and borings that access groundwater must be plugged according to 567--Chapter 39. Contact the IDNR Water Supply Section (515/281-7814) for additional information concerning this requirement. IDNR Form 542-1226 must be completed for all plugged wells and boreholes. Note, however, that monitoring wells used to assess the release under investigation should not be plugged until the department has approved a no action required classification for the site.

1.9 Soil Gas Sampling

Soil gas measurements may be used to evaluate the groundwater vapor to enclosed space and soil vapor to enclosed space pathways. Additionally, soil gas sampling is required to define the soil gas plume for the special assessment procedure required for the groundwater vapor to enclosed pathway in bedrock situations.

For the normal site assessment (non-bedrock situations), soil gas must be sampled at the location of maximum soil concentrations, and at a depth above the water table expected to exhibit the highest gas reading based on field screening and analytical results. In order to verify the soil gas measurement is representative of the maximum expected gas level, a second soil gas sample (confirmational) must be taken at least two weeks from the initial soil gas sampling event. One of the samples (initial or confirmational) must be taken during a seasonal period of lowest groundwater elevation and, if applicable, below the frost line. The following exploratory methods may be used to obtain soil vapor samples:

Option 1: A hollow, small-diameter (minimum 0.5-inch outside diameter), threaded steel casing fitted with a loose-fitting end plug is driven to the appropriate sampling depth. The casing is retracted a minimum of 12 inches to expose the soils in the sidewalls. The end plug should fit such that it remains in place at the bottom of the hole when the casing is retracted. The top of the casing is capped. Allow the soil air to stabilize for at least one hour prior to sampling. When direct-push technologies are used as a means of obtaining soil vapor samples, analysis using portable equipment is not acceptable. Samples must be collected using specialized sampler tubes and sent to a laboratory for analysis.

Option 2: A small-diameter (suggested 3-inch) hand auger boring is extended to appropriate sampling depth. A hollow, 1-inch diameter, threaded PVC casing perforated in the lower 12 inches is placed in the borehole. Sand backfill is placed to a depth not to exceed 18 inches above the bottom of the boring, covering the perforated section of the casing. The remainder of the borehole must be filled with hydrated bentonite to seal around the casing. The top of the casing is capped. Allow the soil air to stabilize for at least one hour prior to sampling.

Soil gas samples must be collected and analyzed using NIOSH Method 1501, or a department-approved equivalent. Soil gas is collected by means of adsorption onto solid activated carbon media. Glass tube samplers which comply with NIOSH Method 1501 and piston-type vacuum samplers are available commercially. The vacuum sampler used must be capable of drawing two hundred milliliters (200 ml) of casing air through the carbon media by either single or incremental operation. The pump must be factory calibrated according to manufacturer's specifications, and fitted with an indicator which visibly shows when the sampling cycle has been completed. Flow rates must be verified and volume checks must be conducted immediately prior to and immediately after sampling. Sampling equipment must be cleaned prior to each sampling event and stored to prevent cross-contamination. Cleaning of equipment must occur away from the sampling location and sufficient time must be allowed for the evaporation of any cleaning solvents which may interfere with chemical analysis.

Consult NIOSH Method 1501 and the instructions provided by the manufacturer of the sampler device for specific sampling procedures. The following general procedures are recommended to obtain a representative soil gas sample:

1. Attach a sufficient length of rubber tubing to the sampling pump to form an air tight seal.
2. Break the tip of the sampler tube and fasten the tube securely to the free end of rubber tubing with the arrow of the sampler tube pointing toward the pump.
3. Insert the sampler tube into the casing and position it so the inlet of the sampler tube is above, but within 6 inches of, the bottom of the casing.
4. Draw a 200 ml volume of soil air through the sampler tube and immediately withdraw it from the borehole casing.
5. Disconnect the sampler tube from the rubber tubing and seal the tube using the plastic caps provided by the vendor.

Standard handling and transporting procedures are used for the sampler tubes including the processing of chain-of-custody forms. Samples must be analyzed for benzene and toluene in accordance with NIOSH Method 1501. Analysis of sample blanks for quality assurance is recommended. One sample blank should be submitted for each sampling event.

1.10 Indoor Vapor Sampling

Indoor vapor measurements may be used to evaluate the groundwater vapor to enclosed space and soil vapor to enclosed space pathways if soil gas measurements exceed the soil gas target levels. Soil gas target levels and indoor vapor target levels are found in section 3.3.6 of this guidance. See sections 3.3 and 3.4 for conditions under which indoor vapor sampling is allowed.

In order to verify the indoor vapor measurement is representative of the maximum expected level, two sampling events must be conducted at least two weeks apart, with one of the sampling events conducted during a seasonal period of lowest groundwater elevation.

Indoor vapor must be sampled in the subsurface portion/room of the structure (i.e., basements, half-basements, etc.), and vapor concentrations are determined for only the enclosed space volume of the subsurface room being tested. Air samples which represent a time-weighted average (TWA), are collected using personal air sampling pumps and solid sorbent tubes (charcoal-filled).

Consult NIOSH Method 1501 and the instructions provided by the manufacturer of the sampler device for specific sampling procedures. The following general procedures are recommended to obtain representative indoor vapor samples:

1. Calibrate the pump according to the manufacturer's specifications. The vacuum pump must be equipped with a meter which indicates the flow rate. Flow rates must be verified and volume checks must be conducted immediately prior to and immediately after sampling.
2. Break the tip of the sampler tube and fasten the tube securely to rubber tubing which is connected to the pump. The arrow of the sampler tube must be pointed toward the pump.
3. Determination of exposure must be made from breathing zone air samples that are representative of an occupant's average exposure to airborne chemicals of concern.
4. Measurements must be taken so that a representative average 8-hour exposure can be determined from a single 8-hour sample or two 4-hour samples. Short time interval samples (grab samples) may also be used to determine average exposure level if a minimum of five(5) measurements are taken in a random manner over an 8-hour time period.
5. Disconnect the sampler tube from the rubber tubing and seal the tube using the plastic caps provided by the vendor.

6. Sampling equipment must be cleaned prior to each sampling event and stored to prevent cross-contamination. Cleaning of equipment must occur away from the sampling location and sufficient time must be allowed for the evaporation of any cleaning solvents which may interfere with chemical analysis.

Indoor vapor samples must be analyzed using NIOSH Method 1501, or a department-approved equivalent. Standard handling and transporting procedures are used for the sampler tubes including the processing of chain-of-custody forms. Samples must be analyzed for benzene and toluene. Analysis of sample blanks for quality assurance is recommended. One sample blank should be submitted for each sampling event.

1.11 Report Submission

Submittal schedule. Owners and operators must submit a Tier 2 site cleanup report within 180 days of the date the department approves the Tier 1 assessment report or if the department does not review the Tier 1 assessment report, within 240 days after the Tier 1 report was submitted to the department. If the owner or operator has elected to conduct a Tier 2 assessment instead of a Tier 1, or a Tier 2 assessment is required due to the presence of free product, the Tier 2 site cleanup report must be submitted within 180 days of the date the release was confirmed. The department may establish an alternative schedule for submittal.

Send one copy of the completed Tier 2 report to the Iowa Department of Natural Resources, LUST Coordinator, Wallace Building, Des Moines, IA 50319-0034 and, if the state UST Fund is being used, one copy to GAB Robins, PO Box 3837, 2600 72nd Street, Suite A, Des Moines, IA 50322.

The completed Tier 2 report form must be accompanied by the attachments, maps, and appendices listed in section 6.9. Title and number each document as directed and attach the documents in the same order as listed. Ensure all maps are legible, have a north arrow, scale and legend. If possible, maps should either be prepared on 8½ x 11 inch paper or reduced to that size by a single fold preferably with north at the top of the page. Additional reports containing pertinent data not required by the Tier 2 assessment may be submitted as attachments. This does not mean photocopy the LUST file and add it as an attachment. However, please ensure the Tier 2 report contains all the information requested.

A checklist of all the components of the Tier 2 report is included with the form to assist with report compilation. Those items which may not be necessary for all reports are labeled “optional”. Information specific to the site will dictate whether some optional items must be included. It is the responsibility of the groundwater professional to determine what site-specific information must be included to produce a complete report. Incomplete Tier 2 reports and Tier 2 reports not submitted in the format required by this document will be rejected.

1.12 Report Review Procedures

A Tier 2 site cleanup report is considered to be complete if it contains all the information and data required by this rule and the department's Tier 2 guidance. The report is considered accurate if the information and data are reasonably reliable based first on the standards in these rules and department guidance, and second, on generally accepted industry standards.

Unless the report proposes to classify the site as no action required, the department must approve the report within 60 days of receipt for purposes of completeness or disapprove the report upon a finding of incompleteness, inaccuracy or noncompliance administrative rules applicable to the RBCA process. If no decision is made within this 60-day period, the report is considered to be approved for purposes of completeness only.

If a no action required site classification is proposed, the 60-day limitation does not apply. The department will review each Tier 2 site cleanup report which proposes a no action required site classification to determine if the data

and information are complete and accurate, the data and information comply with department rules and guidance and the site classification proposal is reasonably supported by the data and information.

Upon approval of the Tier 2 site cleanup report for purposes of completeness or as directed by the department, owners and operators must either implement the corrective action recommendations, including any modifications required by the department, or prepare a Tier 3 site analysis. Owners and operators must monitor, evaluate, and report the results of corrective action activities in accordance with the schedule and on forms or in a format required by the department.

The department may, in the interest of minimizing environmental or public health risks and promoting a more effective cleanup, require owners and operators to begin cleanup of soil and groundwater before the Tier 2 site cleanup report is approved.

1.13 Expedited Corrective Action

An owner, operator or responsible party of a site at which a release of regulated substance is suspected to have occurred may carry out corrective actions at the site provided the department receives notice of the expedited cleanup activities within 30 calendar days of their commencement and the corrective action does not include active treatment of groundwater other than 1) as previously approved by the department; or 2) free product recovery.

Expedited corrective action is not intended to be a substitute for a site check or tiered evaluation. The purpose is to provide a mechanism for limited and prompt remediation without unnecessary delays for proposal submittal, department review, etc. Generally, expedited corrective action is limited to excavation of contaminated soils. Excavation activities must be conducted in accordance with procedures in Subrule 135.12(11) and the soil excavation requirements identified in section 5.6 of this guidance. Excavation may be conducted at any time including in conjunction with a Tier 1 or Tier 2 site assessment. However, adequate sampling must be conducted to determine the levels of contaminants in soil before and after the excavation. Groundwater sampling shall be required as provided in either 135.6(3)b - site check procedures, or 135.9(1) - Tier 1 site assessment procedures. A report of the excavation which includes the information listed in section 5.6 must be submitted as part of a site check report or as an Appendix to the Tier 1 or Tier 2 report, whichever applies.

CHAPTER 2: MODELING

This section provides a general discussion about the models used in the Tier 2 site evaluation and guidance on how to determine the source width and length for modeling use.

2.1 Groundwater model

Tier 2 uses fate and transport models to predict the maximum distance groundwater contamination is expected to migrate and the distribution of concentrations of chemicals of concern within the anticipated plume. The model is used for two basic purposes. One, it is used to predict at what levels of concentration the chemicals of concern would be expected to impact actual and potential receptors. Two, it is used to determine a concentration for chemicals of concern at the source which if achieved, and after dispersion and degradation, would protect actual and potential receptors at the point of exposure. In predicting the transport of contaminants, the models assume the contaminant plume is at "steady state" such that concentrations throughout the plume have reached a maximum level and are steady or decreasing. The Tier 2 models are only designed to predict transport in a direct line between the source and downgradient to a receptor. In order to more reasonably define a modeled plume in all directions, a method for calculating decreasing modeled concentrations as a percentage of their distance in degrees from the downgradient direction must be applied.

2.2 Soil vapor model

The soil vapor model is a vertical transport model and does not use modeling to predict soil contaminant transport horizontally to receptors.

2.3 Soil leaching to groundwater model

The soil leaching to groundwater model predicts the maximum concentrations of chemicals of concern that would be expected in groundwater due to vertical leaching from the area of maximum soil concentrations and then incorporates the groundwater transport models to predict contaminant transport through groundwater pathways.

2.4 Modeling default parameters

The Tier 2 model formulas require the use of site-specific parameters. Due to the difficulty and/or expense in obtaining values, default parameters have been specified in Appendix B of the rules. The default parameters must be used unless otherwise specified. A hydraulic conductivity value (K) of 5 m/d is used when the recharge rate of the well is too rapid to be accurately measured.

2.5 Source width groundwater transport modeling

The source width is a variable used in modeling and must be determined as follows. Determining the source width is **not** the same process as defining the extent of the contaminant plumes.

To determine the source width (S_w in models) for groundwater transport modeling, sum the group one chemical (BETX) concentrations for each groundwater sample. Identify the location of the sample with the maximum total BTEX concentration. Linear interpolation is used to estimate the area where groundwater concentrations would be expected to exceed 50 percent of the maximum BTEX value. This area is considered for the source width measurement. The same procedure is used to determine source width for group two chemicals, using TEH in groundwater. The width of the groundwater contamination source plume, perpendicular to estimated groundwater

flow direction, is considered to be the S_w. The larger S_w measurement of either group one (BETX) or group two chemicals (TEH) is used in the groundwater transport model. Use the greatest measured dimension of the groundwater contamination source width plume if the groundwater gradient is less than 0.005 or the groundwater contaminant plume shows no definitive direction or shows directional reversals. If the direction of plume migration is significantly different from the calculated groundwater flow direction use the S_w measurement perpendicular to plume movement.

When estimating S_w when free product is present, the groundwater from wells with free product must be analyzed for BETX and if applicable, TEH. The wells should be purged prior to sample collection. The groundwater sample should be obtained by lowering a translucent bailer, with a ball valve in the bottom, into the well. The bailer should be carefully lowered through the free product and groundwater interface so that a sample of the groundwater under the free product can be obtained. Avoid the transfer of free product or a free product and groundwater emulsion when filling the sample vial. For those sites with an approved SCR and groundwater data from wells with free product is inadequate, the S_w measurements are taken from the area representing half the distance between wells with free product and wells without free product.

2.6 Source width S_w and length (W in models) for soil leaching to groundwater transport modeling

Measurements for both S_w perpendicular to the estimated groundwater flow direction and W parallel to the estimated groundwater flow direction are used in the soil leaching to groundwater model.

The first step in determining S_w and W is to draw contour lines for the areas of maximum BETX and TEH concentrations in soil and groundwater. BETX and TEH soil concentrations from both the vadose and saturated zone must be considered when determining the maximum concentration. The procedure for determining the contour line for the maximum concentration follows. The example provided is for BETX in soil. The same basic procedure is used to draw the contour lines for the areas of maximum BETX concentration in groundwater and the maximum TEH concentrations in soil and groundwater.

To determine the maximum contour for BETX in soil, sum the BTEX concentrations for each soil sample. The location of the sample with the maximum total BTEX is identified. Linear interpolation is used to estimate the area where soil concentrations would be expected to exceed 50 percent of the maximum BTEX value. The area within the contour is considered for the S_w and W measurements.

Using the same procedure, draw maximum concentration contour lines for BETX in groundwater and TEH in soil and groundwater. The areas within the contours are considered for the S_w and W measurements.

Measure the greatest width of each contour area perpendicular to the groundwater flow direction. The largest of these measurements is S_w .

Measure the greatest width of each contour area parallel to the groundwater flow direction. The largest of these measurements is W.

Use the greatest measured dimension of all the contour areas for S_w and W if the groundwater gradient is less than 0.005, the groundwater contaminant plume shows no definitive direction or shows directional reversals. If the direction of plume migration is significantly different from the calculated groundwater flow direction calculate S_w and W for both directions and use the greatest measurements for modeling.

When estimating S_w and W with free product is present, the groundwater from wells with free product must be analyzed for BETX and TEH. The wells should be purged prior to sample collection. For those sites with an approved SCR and groundwater data from wells with free product is inadequate, the S_w and W measurements are taken from the area representing half the distance between wells with free product and wells without free product.

2.7 Modeled simulation line

The simulation line represents the predicted maximum extent of the groundwater contamination plume and the distribution of contaminant concentrations between the source(s) and actual or potential receptor locations. The model calculates the simulation line by using the maximum concentrations at the source(s) and predicted dispersion and degradation values. Modeled data in the simulation line are compared with actual field data to verify the predictive validity of the model and to make risk classification decisions.

2.8 Modeled site-specific target level (SSTL) line

The modeled SSTL line represents acceptable levels of contaminant concentrations at points between and including the source(s) and an applicable point(s) of exposure or other point(s) of compliance (e.g., a potential receptor point of exposure). The SSTL line is calculated by assuming an applicable target level concentration at the point(s) of exposure or point(s) of compliance and modeling back to the source to determine the maximum acceptable concentration at the source (i.e., site specific target level or SSTL) that must be achieved to meet the target level at the point of exposure or compliance. Comparison of field data to this SSTL line is used to determine a risk classification and determine appropriate corrective action response.

2.9 Crossgradient and upgradient modeling considerations

A percentage of modeled contaminant concentrations are used to determine the SSTL line and simulation line in directions other than downgradient. In general, an angle of 30° to either side of the range of downgradient directions will designate 100 percent of model results, 20 percent of modeled results will be used in the upgradient direction, and a relative proportion will be used for points between these two guidelines.

To determine the simulation line concentration for a cross or up gradient receptor, measure the distance the receptor is from the contamination source. Next calculate the percentage of the modeled results that will be used. Insert the values into the suggested formula : Receptor Distance from Source/Percentage of Modeled Results = Adjusted Simulation Line Distance. The contaminant concentration on the simulation line equal to the adjusted simulation line distance is the modeled concentration at the off-gradient receptor.

To determine the SSTL for a cross or up gradient receptor, measure the distance the receptor is from the contamination source. Next calculate the percentage of the modeled results that will be used. Insert the values into the suggested formula : Receptor Distance from Source X Percentage of Modeled Results = Adjusted SSTL Line Distance. The contaminant concentration on the SSTL line equal to the adjusted SSTL line distance is the modeled SSTL source concentration applicable to the off-gradient receptor.

The groundwater gradient (Head differential between two wells/Horizontal distance between the wells) is determined parallel to the groundwater flow direction and optimally between wells within the groundwater contamination plume. Wells adjacent to the plume may be used if necessary. Gradient measurements will be made corresponding to the different directions if the groundwater has multiple flow directions. The largest gradient measurement will be used for modeling. If the groundwater gradient is less than 0.005 or the groundwater contaminant plume shows no definitive direction or shows directional reversals, values will be assumed to be 100 percent of the modeled values in all directions from the source.

2.10 Plume definition

The purpose of plume definition at Tier 2 is to obtain sufficient data to determine the impact on actual and potential receptors, to determine and confirm the highest levels of contamination, to verify the validity of the models, and to

determine groundwater flow direction. The number and location of borings and monitoring wells and the specificity of plume definition will depend on the pathway or pathways being assessed and the actual or potential receptors of concern. Unless otherwise specified, groundwater and soil contamination shall be defined to Tier 1 levels for the applicable pathways. The specifics of plume definition will be discussed in more detail in the sections about the analysis of individual pathways. Linear interpolation between two known concentrations must be used to delineate plume extent. "None Detected" analytical results shall be considered as one-half the detection limit for interpolation purposes.

2.11 Pathway completeness

All pathways must be evaluated if a Tier 1 analysis has not been conducted. Each pathway, not receiving clearance at Tier 1, must be evaluated at Tier 2. Pathways are generally considered complete if actual or potential receptor points of exposure exist within the modeled contaminant plume as defined by the simulation line calculated to the applicable target level at a point of exposure. If the actual contaminant plume exceeds the modeled plume, the pathway is complete and must be evaluated if actual or potential points of exposure exist within a distance extending 10 percent beyond the edge of the defined plume.

2.12 Points of exposure and compliance

For actual receptors, the point(s) of exposure is the receptor (e.g., drinking water well, house with a basement). For potential receptors, the potential receptor point(s) of exposure is determined by using the actual plume definition or the modeled simulation line to determine all points which exceed the target level(s) for potential receptors. The potential receptor point(s) of exposure are the location(s) closest to the source where a receptor could reasonably exist and which is not subject to an institutional control. For example, the source is the potential receptor point of exposure if not subject to an institutional control or an adjoining property boundary line if that property is not subject to an institutional control. At Tier 2, the point(s) of exposure or potential receptor point(s) of exposure is a point of compliance unless otherwise specified. Other points of compliance are specified by rules and will generally include all points along the SSTL line for purposes of pathway and site classification and corrective action response.

2.13 Group two chemicals

Due to difficulties in precisely measuring the concentrations of naphthalene, benzo(a)pyrene, benz(a)anthracene and chrysene in highly contaminated samples total extractable hydrocarbon (TEH) default values were calculated for each chemical for diesel and for waste oil. The assumption made in the default calculation was that diesel fuel contains 0.2% naphthalene, 0.001% benzo(a)pyrene, 0.001% benz(a)anthracene, and 0.001% chrysene. The assumption made in the default calculation was that waste oil contains no naphthalene, 0.003% benzo(a)pyrene, 0.003% benz(a)anthracene, and 0.003% chrysene. At Tier 2, chemical-specific concentrations for naphthalene, benzo(a)pyrene, benz(a)anthracene, and chrysene may be used for modeling. If chemical-specific concentrations are used, the analytical method must be approved by the department prior to its use. Proposals should document analytical methodologies consistent with those contained in US EPA SW-846. The laboratory conducting the analysis must be able to demonstrate good recovery and precision as directed in the method and a sufficiently low minimum detection limit (MDL) to quantify the compound at concentrations equal to its RBSL.

When modeling, use the Appendix B TEH default values for the individual compounds. Model for each compound using the applicable groundwater transport modeling parameters. Naphthalene and benzo(a)pyrene will generally act as the dominant compounds. The modeled compound concentrations will need to be converted back to TEH default values to determine the SSTL.

CHAPTER 3: ROUTINE ASSESSMENT PROCEDURES

3.1 Groundwater Ingestion Pathway Assessment

3.1.1 Pathway completeness

Unless cleared at Tier 1, this pathway is complete and must be evaluated under any of the following conditions: (1) the first encountered groundwater is a protected groundwater source; or (2) there is a drinking water well or a non-drinking water well within the modeled groundwater plume or the actual plume. The soil leaching to groundwater pathway must be evaluated if this pathway is complete.

3.1.2 Receptor evaluation

All existing drinking water wells and non-drinking water wells within the modeled plume or the actual plume must be evaluated as actual receptors. Potential receptors only exist if the groundwater is a protected groundwater source. Potential receptor points of exposure are those points (e.g., The property where the release occurred and adjacent properties.) within the modeled plume or actual plume that exceed the potential point of exposure target level. Roads and road right-of-ways are not considered potential receptor points. The point(s) of compliance for actual receptor(s) is the receptor. The point(s) of compliance for potential receptor(s) is the potential receptor point of exposure.

3.1.3 Target levels

For drinking water wells, the target level at the point(s) of exposure is the Tier 1 level for actual receptors. For non-drinking water wells, the target level at the point(s) of exposure are the Tier 1 levels for potential receptors. For potential receptors, the target level at the potential receptor point(s) of exposure is the Tier 1 level for potential receptors.

3.1.4 Modeling

At Tier 2, the groundwater well is assumed to be drawing from the contaminated aquifer, and the groundwater transport model is designed to predict horizontal movement to the well. If the groundwater professional determines that assessment of the vertical movement of contamination is advisable to determine the potential or actual impact to the well source, a Tier 3 assessment of this vertical pathway may be conducted. The groundwater professional shall submit a work plan to the department specifying the assessment methods and objectives for approval prior to conducting the Tier 3 assessment. Factors which should be addressed in the work plan include, but are not limited to, well depth and construction, radius of influence, hydrogeologic separation of the aquifer, preferential pathways, and differing water quality characteristics.

3.1.5 Plume definition

The groundwater plume shall be defined to the applicable Tier 1 level for actual receptors in the vicinity of actual receptors. The plume shall be defined to the Tier 1 level for potential receptors in all directions.

3.1.6 Pathway classification

This pathway shall be classified as high risk, low risk or no action required.

3.1.7 Corrective action response

Corrective action must be conducted at high risk sites.

3.1.8 Use of institutional controls

The use of institutional controls may be used to obtain no action required pathway classification. If the pathway is complete and the concentrations exceed the applicable Tier 1 level(s) for actual receptors, the impacted drinking or non-drinking water well must be properly plugged and the institutional control must prohibit the use of a protected groundwater source (if one exists) within the actual or modeled plume. If the Tier 1 level is exceeded for potential

receptors, the institutional control must prohibit the use of a protected groundwater source within the actual or modeled plume, whichever is greater.

3.2 Soil leaching to groundwater pathway assessment

3.2.1 General

The soil leaching to groundwater pathway is evaluated using a one dimensional model which predicts vertical movement of contamination through soil to groundwater and transported by the groundwater to a receptor. The model is used to predict the maximum concentrations of chemicals of concern that would be present in groundwater beneath a source area which is representative of residual soil contamination and maximum soil concentrations. The predicted groundwater concentrations then must be used as a groundwater source concentration to evaluate its impact on other groundwater transport pathways, including the groundwater ingestion pathway, the groundwater vapor pathway, the groundwater plastic line pathway and the surface water pathway.

3.2.2 Pathway completeness

This pathway is considered complete whenever a groundwater transport pathway is complete.

3.2.3 Plume definition

The soil plume shall be defined to the Tier 1 levels for the soil leaching to groundwater pathway.

3.2.4 Receptor evaluation

Receptors for this pathway are the same as the receptors for each complete groundwater transport pathway.

3.2.5 Modeling and target levels

The soil leaching to groundwater model shall be used to calculate the predicted groundwater source concentration. Each applicable groundwater transport pathway model shall then be used for that pathway to predict the potential impact to actual receptors, the location of potential receptor points of exposure and the site-specific target level (SSTL) in groundwater at the source. The SSTL then is used to calculate a SSTL for soil at the source. If the soil concentrations exceed the SSTL for soil, corrective action response must be considered.

3.2.6 Corrective action response

If the maximum soil concentration at the source exceeds the SSTL for soil for actual or potential receptors, corrective action must be taken. For a site classified as high risk or reclassified as high risk, corrective action consists of active remediation to reduce the soil concentration to below the site-specific target level at the source.

3.3 Groundwater vapor to enclosed space pathway assessment

Pathway completeness

Unless cleared at Tier 1, this pathway is always considered complete for purposes of Tier 2 and must be evaluated.

Explosive vapor survey

If an explosive vapor survey has not been conducted as part of a Tier 1 assessment, an explosive vapor survey of enclosed spaces must be conducted during the Tier 2 assessment in accordance with the procedures outlined in the department's Tier 1 guidance. If potentially explosive levels are detected, the groundwater professional must notify the owner or operator with instructions to report the condition in accordance with 567--Chapter 131. The owner or operator must begin immediate response and abatement procedures in accordance with 135.7 and 567--Chapter 133, as well as proceed with the Tier 2 assessment.

Receptors of concern

Actual and potential receptors are evaluated at Tier 2 for this pathway.

Actual receptors. An existing confined space within the modeled groundwater plume or the actual groundwater plume is an actual receptor. If the actual groundwater plume is larger than the modeled plume, existing confined spaces within a distance extending 10 percent beyond the edge of the defined plume is an actual receptor. For the purpose of Tier 2, a confined space is a basement in a building occupied by humans. Buildings constructed with a concrete slab on grade or buildings constructed without a concrete slab, but with a crawl space are not considered confined spaces. Sanitary sewers are considered confined space receptors and preferential pathways if an occupied building exists within 200 feet of where the sewer line crosses over or through actual or modeled groundwater contamination which exceeds the target levels calculated for sewers. The sanitary sewer includes its utility envelope. The point of exposure is the receptor and points of compliance include locations from the source to the receptor where actual contaminant levels are measured and compared with modeled data for classification and corrective action evaluation purposes.

Owners and operators may be required to address vapor inhalation hazards in occupied spaces other than confined spaces as defined in this section when evidence arises which would give the department a reasonable basis to believe vapor hazards are present or may occur.

Potential receptors. Potential receptors are confined spaces that do not presently exist but could exist in the future. Areas within the actual groundwater plume perimeter or modeled groundwater plume perimeter are considered potential receptor points of exposure. If the actual groundwater plume is larger than the modeled plume, areas within a distance extending 10 percent beyond the edge of the defined plume are potential receptor points of exposure. Public right-of-ways are considered potential receptor points of exposure for sanitary sewers only. The potential receptor point of exposure is a point of compliance. Potential receptors are evaluated and target levels established based on the current zoning (i.e., commercial or residential).

Plume definition

The soil plume must be defined for the purposes of estimating source width and source length used in soil leaching to groundwater and groundwater transport models. See Sections 2.5 and 2.6 of this guidance. The groundwater plume must be defined to the Tier 1 levels for the purpose of identifying receptors of concern. The receptors may then be re-evaluated, and possibly eliminated as receptors of concern by using target levels derived from site-specific data as provided below.

Target levels for groundwater

Groundwater target levels at the point of exposure may be calculated using the Tier 1 formulas and site-specific measurements rather than default values for certain parameters as specified in subsequent paragraphs. . For buildings with basements, target levels at the point of exposure are based on the application of a target risk of 10^{-4} for carcinogens and a hazard quotient of 1 for noncarcinogens. Sanitary sewers are treated as human health receptors and a target risk of 2×10^{-4} for carcinogens and a hazard quotient of 2 for noncarcinogens is applied. Additionally, target levels at the point of exposure will vary based on zoning. For residential areas and areas with no zoning, default residential exposure factors and default residential building parameters are used in the Tier 1 formulas. For nonresidential areas, nonresidential exposure factors and nonresidential building parameters are used. For potential sanitary sewers, public right-of-ways will be considered residential areas unless it can be demonstrated that all properties within 200 feet of the contaminated right-of-way are zoned for nonresidential use. However, for properties other than right-of-ways, the target level for potential sanitary sewer receptors is based on the zoning of the impacted property.

If site-specific measurements ***are not*** substituted for defaults in the Tier 1 formulas, target levels at the point of exposure for the various receptor types are as follows:

Default Groundwater Target Levels at the Point of Exposure				
Receptor Types	Chemicals of Concern (ug / L)			
	Benzene	Toluene	Ethylbenzene	TEH
Actual Confined Space -- Residential	1540	20,190	46,000	2,200,000
Actual Sanitary Sewer -- Residential	3080	40,390	91,930	4,400,000
Actual Confined Space -- Nonresidential	4780	52,280	118,970	5,700,000
Actual Sanitary Sewer -- Nonresidential	9550	104,910	**NA**	11,400,000
Potential Confined Space -- Residential	1540	20,190	46,000	2,200,000
Potential Sanitary Sewer -- Residential	3080	40,390	91,930	4,400,000
Potential Confined Space -- Nonresidential	4780	52,280	118,970	5,700,000
Potential Sanitary Sewer -- Nonresidential	9550	104,910	**NA**	11,400,000

Default Exposure Factors Based on Zoning			
Parameter		Residential	Nonresidential
AT_c (years)	averaging time for carcinogens	70	70
AT_n (years)	averaging time for noncarcinogens	30	25
BW (kg)	body weight	70	70
ED (years)	exposure duration	30	25
EF (days/year)	exposure frequency	350	250
IR_{air} (m^3/day)	daily indoor inhalation rate	15	20
IR_w (L/day)	daily water ingestion rate	2	1
THQ (unitless)	target hazard quotient for individual constituents	1.0	1.0

Default Building Parameters Based on Zoning			
Parameter		Residential	Nonresidential
ER (s^{-1})	enclosed space air exchange rate	0.00014	0.00023
L_B (cm)	enclosed space volume/infiltration area ratio	200	300
L_{crack} (cm)	enclosed space foundation or wall thickness	15	15
η	areal fraction of cracks in foundation/wall	0.01	0.01

A site-specific measurement may be substituted for depth to groundwater from the enclosed space foundation (L_{gw}). The depth to groundwater should be measured as close as possible to any existing confined space receptors which may be impacted. Because of variations in groundwater and foundation depths, a different target level at the point of exposure, and consequently a different SSTL may be determined for each receptor. If no receptors currently exist, to determine target levels at potential receptor points of exposure, the foundation of any potential receptor is assumed to be three meters below the surface and L_{gw} is determined accordingly.

The enclosed space volume / infiltration area ratio (L_B) may also be measured for any existing building receptor. The enclosed space volume is a measure of only the subsurface interior portion of the building. The infiltration area is the area of the exterior subsurface portion of the building including the base and all sidewalls.

Target levels for vapor

The following indoor vapor target levels apply to actual receptors other than sanitary sewers and the soil gas target levels apply to all actual and potential receptors. These levels were derived from the ASTM indoor air inhalation and the soil vapor to enclosed space models designated in Appendix A of Chapter 135. Site-specific measurements **may not be used** to recalculate indoor vapor or soil gas target levels.

Vapor Target Levels			
Sample Media	Unit Equivalents	Chemicals of Concern	
		Benzene	Toluene
Soil Gas	$\mu g/m^3_{air}$	600,000	9,250,000
	ppm	190	2,500
Indoor Vapor	$\mu g/m^3_{air}$	39.2	555
	ppm	0.0124	0.15

Pathway evaluation

Groundwater measurements, and under conditions specified below, soil gas measurements, or indoor vapor measurements are used to evaluate this pathway and determine the pathway classification.

Actual receptors. If it can be demonstrated that the groundwater plume has reached steady state concentrations under a confined space, indoor vapor measurements at the point(s) of exposure and soil gas measurements at an alternative point(s) of compliance may be used for the pathway evaluation. When assessing sanitary sewers for pathway clearance, soil gas measurements may be evaluated against the soil gas target levels; however, indoor vapor cannot be used as criteria for pathway clearance.

The groundwater plume is considered to have reached steady state when concentrations from the three most recent consecutive groundwater samples from all monitoring wells show a steady or declining trend in contaminant concentrations. Contaminant concentrations in the first of the three samples from the source well and transition well must be greater than the detection limits; concentrations cannot increase more than 20 percent from the first to the third sample; concentrations cannot increase more than 20 percent of the previous sample; and sampling events must be separated by at least six months.

Soil gas sampling must be conducted in accordance with the procedures specified in section 1.9 of this guidance. Soil gas measurements must be taken at locations in the plume where measured groundwater concentrations exceed the levels which are projected by modeling to exist beneath the actual receptor. If measured groundwater concentrations beneath the actual receptor exceed the levels projected from modeling, then the soil gas measurements may be taken either adjacent to the actual receptor in areas expected to exhibit the greatest soil gas levels, or at an alternative point of compliance between the source and receptor where the actual groundwater concentrations exceed the groundwater concentrations which exist beneath the confined space. Confirmation sampling is required to reasonably establish that the soil gas samples represent the highest expected levels. Therefore, a second soil gas sample must be taken from the same general location at least two weeks from the initial soil gas sampling event. One of the samples (initial or confirmational) must be taken during a seasonal period of lowest groundwater elevation and below the typical frost line.

If the soil gas target levels are exceeded, either the pathway shall be classified high risk, or indoor vapor measurements may be taken in accordance with section 1.10 of this guidance. Confirmation sampling is required to reasonably establish that the indoor vapor samples represent the highest expected levels. Therefore, indoor vapor sampling must be repeated at least two weeks from the initial indoor vapor sampling event. One of the sampling events (initial or confirmational) must be conducted during a seasonal period of lowest groundwater.

Potential receptors. If the potential receptor groundwater concentration target level(s) is exceeded at any potential receptor point of exposure based on actual data or modeling, the pathway shall be classified low risk. However, if soil gas measurements and confirmation sample measurements taken at locations exhibiting the maximum measured groundwater concentrations do not exceed the soil gas target levels, the pathway, as to potential receptors, shall be classified no action required.

Pathway classification

The following classification applies for this pathway:

High risk. The pathway is classified high risk if:

1) any actual field data exceed the site-specific target level line at any point for an actual receptor, and soil gas measurements were not taken; or
2) the explosivity levels at applicable points of compliance exceed 10 percent of the lower explosivity limit (LEL); or
3) for actual receptors, the soil gas levels exceed the soil gas target levels, and indoor vapor measurements were not taken; or
4) the indoor vapor levels exceed the Tier 1 indoor vapor target levels.

Low risk. The pathway is classified low risk if:

1) for actual and potential receptors, the modeled data and the actual field data are less than the site-specific target level line, and any of the field measurements are greater than the simulation line; or
2) for potential receptors, any actual field measurements exceed the site-specific target level line at any point.

No action required. Appropriate evaluation of both actual receptors and potential receptors as specified above must be conducted, and the no action required criteria for both receptor types must be met in order for the pathway to be classified no action required. The pathway is classified no action required if the explosivity levels at applicable points of compliance do not exceed 10 percent of the lower explosivity limit (LEL) **and**:

1) all field data are below the target levels at the point of exposure (and potential receptors points of exposure) calculated using default or site-specific data. (For example, if the groundwater plume has been defined to 1540 ppb benzene, no confined spaces currently exist within the actual or modeled plumes, the highest groundwater concentration is 3000 ppb benzene, and the properties encompassed by the plumes are zoned for nonresidential use, then the site would be classified no action required.); **or**

2) a. the soil gas levels taken at the applicable points of compliance for potential and actual receptors do not exceed the soil gas target levels; **and**
   b. if indoor vapor measurements were taken, the indoor vapor levels do not exceed the indoor vapor target levels.

Corrective action response

Unless classified as no action required, corrective action for this pathway must be conducted as provided in Chapter 5 of this guidance. If groundwater concentrations exceed or are predicted to exceed the target levels in a public right-of-way, the public authority responsible for sanitary sewer installation must be notified of conditions at the site including the potential for creating a preferential pathway for vapor migration should a sewer be installed later. The form used to notify the municipality is an attachment to this guidance. Actual receptors are subject to corrective

actions which: (1) reduce groundwater concentrations beneath the confined space to below the target level; or (2) reduce the measured soil gas levels to below the soil gas target levels; or (3) reduce the indoor vapor concentrations to below the indoor vapor target level; and (4) reduce the vapor level to below 10 percent of the lower explosive limit (LEL), if applicable. Potential receptors are subject to the monitoring requirements in sections 5.3 and 5.4. Soil vapor monitoring may be conducted in lieu of groundwater monitoring for this pathway. Institutional or technological controls may be used under the conditions specified below and in section 5.5.

Use of institutional controls

If the pathway is classified low risk due to potential receptors only, the pathway may be reclassified no action required with the use of institutional controls. The institutional control must prohibit installation of buildings with basements and sanitary sewers in the potential receptor point of exposure areas (i.e., anywhere within the actual or modeled plume as defined to the applicable target level). Public right-of-ways located within the actual or modeled plume are considered potential receptor points of exposure for sanitary sewers only. Consequently, the existence of a public right-of-way is deemed an acceptable institutional control which prohibits the future placement of buildings with basements within the contaminated right-of-way area. Adequate documentation that there is no potential for sewer installation in the impacted public right-of-way may serve as a sufficient institutional control for sanitary sewer receptors in these areas (e.g., written acknowledgment regarding plans for development from the municipality responsible for sanitary sewer construction, etc.). The department will review the documentation and determine on a case by case basis whether there is a potential for sanitary sewer installation in the contaminated right-of-way.

If the public authority has existing plans for the installation of sanitary sewers, the pathway cannot be classified no action required. The pathway may remain classified as low risk subject to monitoring until the construction of the sanitary sewer. At that time, the site must be re-evaluated to address the new actual sanitary sewer receptor.

3.4 Soil vapor to enclosed space pathway assessment

Pathway completeness

Unless cleared at Tier 1, this pathway is always considered complete for purposes of Tier 2 and must be evaluated.

Explosive vapor survey

If an explosive vapor survey has not been conducted as part of a Tier 1 assessment, an explosive vapor survey of enclosed spaces must be conducted during the Tier 2 assessment in accordance with the procedures outlined in the department's Tier 1 guidance. If potentially explosive levels are detected, the groundwater professional must notify the owner or operator with instructions to report the condition in accordance with 567--Chapter 131. The owner or operator must begin immediate response and abatement procedures in accordance with 135.7 and 567--Chapter 133, as well as proceed with the Tier 2 assessment.

Receptors of concern

Actual and potential receptors are evaluated at Tier 2 for this pathway.

Actual receptors. An existing confined space within 50 feet of the edge of the plume is an actual receptor. For the purpose of Tier 2, a confined space is a basement in a building occupied by humans. Buildings constructed with a concrete slab on grade or buildings constructed without a concrete slab, but with a crawl space are not considered confined spaces. Sanitary sewers are considered confined space receptors and preferential pathways if an occupied building exists within 200 feet of where the sewer line crosses over or through soil contamination which exceeds the target levels calculated for sewers. The sanitary sewer includes its utility envelope. The point of exposure is the receptor and points of compliance include the locations where target level measurements may be taken as indicated in the pathway evaluation subsection below.

Owners and operators may be required to address vapor inhalation hazards in occupied spaces other than confined spaces as defined in this section when evidence arises which would give the department a reasonable basis to believe vapor hazards are present or may occur.

Potential receptors. Potential receptors are confined spaces that do not presently exist but could exist in the future. Areas within the soil plume as defined to the Tier 1 levels or an alternative target levels as specified below are considered potential receptor points of exposure. Public right-of-ways are considered potential receptor points of exposure for sanitary sewers only. The potential receptor point of exposure is a point of compliance. Potential receptors are evaluated and target levels established based on the current zoning (i.e., commercial or residential). An area with no zoning is considered residential.

Plume definition

The soil plume must be defined for this pathway unless vapor measurements taken at the area(s) with the maximum levels of soil contamination do not exceed the soil gas target levels as defined in section 3.3.6 of this guidance. The soil plume must be defined to the Tier 1 levels for the purpose of identifying receptors of concern. The receptors may then be re-evaluated, and possibly eliminated as receptors of concern by using target levels derived from site-specific data as provided below.

Target levels for soil

Soil target levels at the point of exposure may be calculated using the Tier 1 formulas and site-specific measurements rather than default values for certain parameters as specified in subsequent paragraphs. For buildings with basements, target levels at the point of exposure are based on the application of a target risk of 10^{-4} for carcinogens and a hazard quotient of 1 for noncarcinogens. Sanitary sewers are treated as human health receptors and a target risk of 2×10^{-4} for carcinogens and a hazard quotient of 2 for noncarcinogens is applied. Additionally, target levels at the point of exposure will vary based on zoning. For residential areas and areas with no zoning, default residential exposure factors and default residential building parameters are used in the Tier 1 formulas. For nonresidential areas, nonresidential exposure factors and nonresidential building parameters are used. The default exposure factors and building parameters are specified in section 3.3.5 of this guidance. For potential sanitary sewers, public right-of-ways will be considered residential areas unless it can be demonstrated that all properties within 200 feet of the contaminated right-of-way are zoned for nonresidential use. However, for properties other than right-of-ways, the target level for potential sanitary sewer receptors is based on the zoning of the impacted property.

If site-specific measurements ***are not*** substituted for defaults in the Tier 1 formulas, target levels at the point of exposure for the various receptor types are as follows:

Default Soil Target Levels at the Point of Exposure

Receptor Types	Chemicals of Concern (mg / kg)			
	Benzene	Toluene	Ethylbenzene	TEH
Actual Confined Space -- Residential	1.16	48	79	47,500
Actual Sanitary Sewer -- Residential	2.32	96	158	95,000
Actual Confined Space -- Nonresidential	2.19	75	124	74,000
Actual Sanitary Sewer -- Nonresidential	4.38	150	248	148,000
Potential Confined Space -- Residential	1.16	48	79	47,500
Potential Sanitary Sewer -- Residential	2.32	96	158	95,000
Potential Confined Space -- Nonresidential	2.19	75	124	74,000
Potential Sanitary Sewer -- Nonresidential	4.38	150	248	148,000

Site-specific measurements may be substituted for the following soil parameters: soil bulk density (ρ_S), fraction organic carbon in soil (f_{oc}), and total soil porosity (θ_T). If the default soil parameter values are to be replaced with site-specific values, all three soil parameters must be measured and used to calculate the soil target levels. Soil samples for soil parameter analysis must be collected at the same depth and in the same stratigraphy as that of the maximum soil contamination location. The sample for fraction organic carbon determination must be collected from an uncontaminated area. Samples for soil bulk density and total soil porosity may be collected from within the plume or from an uncontaminated area.

A site-specific measurement may be substituted for depth to subsurface soil sources from the enclosed space foundation (L_S). The depth to soil contamination should be measured in the area where soil contamination is expected to be closest to the ground surface. If the available data show soil contamination at various depths, the depth closest to the ground surface must be used for L_S in the target level calculation. If a site-specific measurement is used for L_S, documentation must be provided to substantiate the L_S value used in the equation is accurate. Documentation shall include, but is not limited to, boring logs with the field screening results indicated, analytical data, and measured depth of basement foundation. If adequate documentation cannot not be provided, the default value must be used. If no receptors currently exist, to determine target levels at potential receptor points of exposure, the foundation of any potential receptor is assumed to be three meters below the surface and L_S is determined accordingly.

The enclosed space volume / infiltration area ratio (L_B) may also be measured for any existing building receptor. The enclosed space volume is a measure of only the subsurface interior portion of the building. The infiltration area is the area of the exterior subsurface portion of the building including the base and all sidewalls.

Target levels for vapor

The vapor target levels are defined in section 3.3.6 of this guidance. Indoor vapor target levels apply to actual receptors other than sanitary sewers and the soil gas target levels apply to all actual and potential receptors. Site-specific measurements **may not be used** to recalculate indoor vapor or soil gas target levels.

Pathway evaluation

Soil measurements, and under conditions specified below, soil gas measurements, or indoor vapor measurements are used to evaluate this pathway and determine the pathway classification. Soil gas sampling must be conducted in accordance with the procedures specified in section 1.9 of this guidance.

Actual receptors. If measured soil concentrations beneath the actual receptor exceed the soil target levels, then soil gas sampling adjacent to the actual receptor in areas expected to exhibit the greatest soil gas levels is recommended. If this is not practicable, soil gas must be measured at an alternative point of compliance between the source and receptor in areas expected to exhibit the greatest soil gas levels. Confirmation sampling is required to reasonably establish that the soil gas samples represent the highest expected levels. Therefore, a second soil gas sample must be taken from the same general location at least two weeks from the initial soil gas sampling event. One of the samples (initial or confirmational) must be taken during a seasonal period of lowest groundwater elevation and below the typical frost line. If the soil gas measurements and confirmation sample measurements do not exceed the soil gas target levels, the pathway as to actual receptors shall be classified no action required.

If the soil gas target levels are exceeded, either the pathway shall be classified high risk, or indoor vapor measurements may be taken in accordance with the section 1.10 of this guidance. Confirmation sampling is required to reasonably establish that the indoor vapor samples represent the highest expected levels. Therefore, indoor vapor sampling must be repeated at least two weeks from the initial indoor vapor sampling event. One of the sampling events (initial or confirmational) must be conducted during a seasonal period of lowest groundwater.

When assessing sanitary sewers for pathway clearance, soil gas measurements may be evaluated against the soil gas target levels; however, indoor vapor cannot be used as criteria for pathway clearance.

Potential receptors. If the soil concentration target level(s) is exceeded at any potential receptor point of exposure, the pathway shall be classified low risk. However, if soil gas measurements and confirmation sample measurements taken at locations exhibiting the maximum measured soil concentrations do not exceed the soil gas target levels, the pathway shall be classified no action required.

Pathway classification

For the soil vapor to enclosed pathway there are no horizontal transport models to predict future impacts. Therefore, sites are classified as high risk, low risk or no action based on criteria specified below:

High risk. The pathway is classified high risk for **actual receptors** if:
1) measured soil concentrations exceed the target level(s), and soil gas measurements were not taken; or
2) the explosivity levels at applicable points of compliance exceed 10 percent of the lower explosivity limit (LEL); or
3) the soil gas levels exceed the soil gas target levels, and indoor vapor measurements were not taken; or
4) the indoor vapor levels exceed the Tier 1 indoor vapor target levels.

Low risk. The pathway is classified low risk if there are no actual receptors and measured soil concentrations exceed the soil target level(s) at any potential receptor point of exposure.

No action required. Appropriate evaluation of both actual receptors and potential receptors as specified above must be conducted, and the no action required criteria for both receptor types must be met in order for the pathway to be classified no action required. The pathway is classified no action required if the explosivity levels at applicable points of compliance do not exceed 10 percent of the lower explosivity limit (LEL), **and**:

1) measured soil concentrations are below the target levels at the point of exposure (and potential receptors points of exposure) calculated using default or site-specific data; **or**

2) a. the soil gas levels measured at the applicable points of compliance for potential and actual receptors do not exceed the soil gas target levels; **and**
b. if indoor vapor measurements were taken, the indoor vapor levels do not exceed the indoor vapor target levels.

Corrective action response

Unless classified as no action required, corrective action for this pathway must be conducted as provided in Chapter 5 of this guidance. If soil concentrations exceed the target levels in a public right-of-way, the public authority responsible for sanitary sewer installation must be notified of conditions at the site including the potential for creating a preferential pathway for vapor migration should a sewer be installed later. The form used to notify the municipality is an attachment to this guidance. Actual receptors are subject to corrective actions which: 1) reduce the soil concentrations to below the soil target levels; or (2) reduce the indoor vapor concentrations to below the indoor vapor target level; or (3) reduce the measured soil gas levels to below the soil gas target levels; and (4) reduce the vapor level to below 10 percent of the lower explosive limit (LEL), if applicable. Potential receptors are subject to the monitoring requirements in sections 5.3 and 5.4. Soil gas monitoring must be conducted at a minimum of once per year in the area(s) of expected maximum vapor concentrations where an institutional control is not in place. Institutional or technological controls may be used under the conditions specified below and in section 5.5.

Use of institutional controls

If the pathway is classified low risk due to potential receptors only, the pathway may be reclassified no action required with the use of institutional controls. The institutional control must prohibit installation of buildings with basements and sanitary sewers in the potential receptor point of exposure areas (i.e., anywhere within the plume as

defined to the applicable target level). Public right-of-ways located within the soil plume are also considered potential receptor points of exposure. Adequate documentation that there is no potential for sewer installation in the impacted public right-of-way may serve as a sufficient institutional control for these areas (e.g. written acknowledgment regarding plans for development from the municipality responsible for sanitary sewer construction, etc.). The department will review the documentation and determine on a case by case basis whether there is a potential for sanitary sewer installation in the contaminated right-of-way.

If the public authority has existing plans for the installation of sanitary sewers, the pathway cannot be classified no action required. The pathway may remain classified as low risk subject to monitoring until the construction of the sanitary sewer. At that time, the site must be re-evaluated to address the new actual sanitary sewer receptor.

3.5 Groundwater to plastic water line pathway assessment

3.5.1 Pathway completeness and receptor evaluation

Actual receptors. Actual receptors include all plastic water lines where the highest groundwater elevation is higher than three feet below the bottom of the plastic line at the measured or predicted points of exposure. The highest groundwater elevation is the estimated average of the highest measured groundwater elevations for each year. All plastic water lines must be evaluated for this pathway regardless of distance from the source and regardless of the Tier 1 evaluation, if the lines are in areas with modeled data above the SSTL line. If actual data exceed modeled data, then all plastic water lines are considered actual receptors if they are within a distance extending 10 percent beyond the edge of the contaminant plume defined by the actual data.

Potential receptors. Potential receptors include all areas where the first encountered groundwater is less than 20 feet deep and where actual data or modeled data are above Tier 1 levels.

The point(s) of exposure is the plastic water line, and the points of compliance are monitoring wells between the source and the plastic water line which would be effective in monitoring whether the line has been or may be impacted by chemicals of concern.

3.5.2 Plume definition

If this pathway is complete for an actual receptor, the groundwater plume must be defined to the Tier 1 levels, with an emphasis between the source and any actual plastic water lines. The water inside the plastic water lines shall be analyzed for all chemicals of concern. Suggested sampling locations are faucets located in buildings serviced by the impacted water line. The sample collection method should be designed to insure the highest concentrations of the chemicals of concern are obtained if they are present. For example, excessive flushing of the plastic water line should be avoided prior to collecting the water sample. Do not sample at locations where the water has run through a point of use treatment system.

3.5.3 Target levels

Groundwater modeling must be used to calculate the projected concentrations of chemicals of concern and site-specific target levels. The soil leaching to groundwater pathway must be evaluated to ensure contaminated soil will not cause future groundwater concentrations to exceed site-specific target levels.

3.5.4 Pathway classification

Upon completion of analysis of field data and modeled data, the pathway must be classified high risk, low risk or no further action. The water quality inside the plastic water lines is not a criteria for clearance of this pathway.

3.5.5 Utility company notification

The utility company which supplies water service to the area must be notified of all actual and potential plastic water line impacts. If the extent of contamination has been defined, this information must be included in the utility company notification, and any previous notification made at Tier 1 must be amended to include this information. Department forms to make the required notification are provided in this guidance document.

3.5.6 Corrective action response

Actual receptors. Unless the pathway is classified as no further action, corrective action for this pathway must be conducted. If the concentrations of chemicals of concern in a water line exceed the Tier 1 levels for actual receptors for the groundwater ingestion pathway, immediate corrective action must be conducted to eliminate exposure to the water, including but not limited to replacement of the line with an approved non-plastic material.

Potential receptors. A no further action designation will be assigned to this pathway when utility company notification has been documented.

3.6 Soil to plastic water line pathway assessment.

3.6.1 Pathway completeness and receptor evaluation

Actual receptors. Actual receptors include all areas within ten feet of a plastic water line. All plastic water lines must be evaluated for this pathway regardless of distance from the source, if the lines are in areas where Tier 1 levels are exceeded.

Potential receptors. Potential receptors include all areas where Tier 1 levels are exceeded.

3.6.2 Plume definition

The extent of soil contamination must be defined to Tier 1 levels for the chemicals of concern.

3.6.3 Pathway classification

Upon completion of analysis of field data and modeled data, the pathway must be classified high risk, low risk or no further action. Sites shall be classified as high risk if the target levels for actual receptors are exceeded. Sampling the water inside the plastic water lines for all chemicals of concern is strongly suggested when Tier 1 soil levels are exceeded. The sampling results are not allowed as criteria to clear this pathway. Suggested sampling locations are faucets located in buildings serviced by the impacted water line. The sample collection method should be designed to insure the highest concentrations of the chemicals of concern are obtained if they are present. For example, excessive flushing of the plastic water line should be avoided prior to collecting the water sample. Do not sample at locations where the water has run through a point of use treatment system.

3.6.4 Utility company notification

The utility company which supplies water service to the area must be notified of all actual and potential plastic water line impacts. If the extent of contamination has been defined, this information must be included in utility company notification, and any previous notification made at Tier 1 must be amended to include this information. Department forms to make the required notification are provided in this guidance document.

3.6.5 Corrective action response

Actual receptors. Unless the pathway is classified as no further action, corrective action for this pathway must be conducted. Corrective action consists of by active remediation of soil contamination below the target level at the point(s) of exposure or other designated point(s) of compliance.

Potential receptors. Potential receptors. No further action designation will be assigned to this pathway upon documentation of utility company notification.

3.7 Surface water pathway assessment

This pathway assessment involves determining the impact of petroleum contamination on general use and designated use surface waters. Specific definitions for general use and designated use are found in Chapter 567-61.3(1). Selections from this chapter on water quality standards are found in Appendix G of this guidance.

3.7.1 Pathway completeness

Unless maximum concentrations are less than applicable Tier 1 levels, this pathway is complete and must be evaluated if there is a designated use surface water within the modeled or actual groundwater plume or if any surface water body failed the Tier 1 visual inspection.

The Tier 1 visual inspection consists of inspecting all surface water bodies within 200 feet of the source for evidence of a sheen on the water or petroleum residue along the bank. If a sheen or residue is evident or has been reported to be present, the groundwater professional must make a sufficient investigation to reasonably determine its source. If in the opinion of the groundwater professional, the sheen is not associated with the underground storage tank site, the professional must report and reasonably justify this opinion. If in the opinion of the groundwater professional the sheen is not a petroleum-regulated substance, a sample must be laboratory tested to confirm it is not a petroleum-regulated substance.

3.7.2 Visual inspection

A visual inspection must be conducted as described above. If a sheen or residue from a petroleum-regulated substance is present, soil and groundwater sampling must be conducted to identify the source of the release and to define the extent of the contaminant plume to the levels acutely toxic to aquatic life.

3.7.3 Receptor evaluation

Surface water criteria apply only to designated use segments of surface water bodies. If the surface water body is a designated use segment and if maximum groundwater concentrations exceed applicable surface water criteria, the extent of contamination must be defined. The point of compliance for measuring chemicals of concern at the point of exposure is the groundwater adjacent to the surface water body because surface water must be protected for low flow conditions. In-stream measurements of concentrations are not allowed as a basis for no further action. Monitoring wells must be placed as close as possible to the surface water body being assessed. This may require the hand augering of monitoring wells.

If the visual inspection indicated the presence of a petroleum sheen in a general use segment within 200 feet of the source, the segment must be evaluated as an actual receptor. The point of compliance for measuring the chemicals of concern at the point of exposure is the groundwater adjacent to the general use segment.

3.7.4 Plume definition

For designated use segments: the groundwater plume must be defined to the surface water criteria levels, with an emphasis between the source and the surface water body.

Surface Water Criteria for Designated Uses for LUST Sites (all in ppb)

Designated Uses for Surface Water Classification	A	B(CW)	B(WW)	B(LR)	B(LW)	C
	Primary Contact Recreation	Aquatic Life				
		Cold Water	Warm Water	Limited Resources	Lakes & Wetlands	Drinking Water
Benzene	---	713	713	---	713	5
Ethylbenzene	---	---	---	---	---	700
Toluene*	---	1,000	1,000	1,000	1,000	1,000
Xylenes	---	---	---	---	---	10,000
TEH**	---	---	---	---	---	---

* Chronic levels for toluene are higher in Chapter 135 than in Chapter 61.

**Naphthalene is not currently in Table 1 of Chapter 61. Benzo(a)pyrene, Benz(a)anthracene, and Chrysene are carcinogenic PAHs. Polynuclear Aromatic Hydrocarbons (PAHs) are in Table 1 of Chapter 61 as the total known and suspected carcinogenic PAHs. Because no method has been identified to convert total PAHs to a TEH value, there are no surface water criteria for TEH for LUST sites at this time.

For all surface water: if the visual inspection was not passed, the groundwater plume must be defined to at least the acutely toxic levels, with an emphasis between the source and the surface water body.

Acutely Toxic Levels* for General Water Quality (all in ppb)

Species:	Fathead Minnows	Bluegill
Apply Level to:	All Surface Water	Ponds & Lakes
Benzene:	16,500	11,000
Ethylbenzene:	22,650	16,000
Toluene:	19,050	8,750
Xylenes:	---	---
TEH-Diesel**	1,650,000	50,000,000
TEH-Waste Oil**	NA	5,000,000
Naphthalene	3,300	---
Benz(a)anthracene	---	500

*DNR Water Quality staff use half the LC_{50} values for the standard for acutely toxic levels. These standards are shown in the table above.

--- No LC_{50} data available. Also not available for Benzo(a)pyrene, or Chrysene

** TEH values are based on the values for naphthalene and benz(a)anthracene as shown in the table. They were calculated using the default percentages listed in Appendix B of Chapter 135.

3.7.5 Target levels

Determining target levels for this pathway involves a two-step process.

1. Groundwater modeling must be used to calculate the projected concentrations of chemicals of concern at the point of compliance. If the modeled concentrations or field data at the point of compliance exceed surface water criteria for designated use segments, an allowable discharge concentration must be calculated. If the projected concentrations and field data at the point of compliance do not exceed surface water criteria, no further action is required to assess this pathway.

2. DNR Water Quality staff will calculate the allowable discharge concentration using information provided by the certified groundwater professional on the Allowable Discharge Concentration form found at the end of this guidance.

Directions for the Allowable Discharge Concentration form

a. Complete Section I on Site Information.

1. Receiving Stream Network: Name the surface water of concern. If it is an unnamed stream or drainage ditch, continue listing the tributaries until a named surface water body is listed. Example: Unnamed drainage ditch which flows into an unnamed creek which flows into the Middle Raccoon River.

2. Discharge Flow Rate:
The formula for calculating the discharge flow rate is Q = (K) (i) (L) (3) (C). Where:

Q = Flow rate of contaminated groundwater (cubic feet per second)
K = Hydraulic conductivity (meters/day)
i = Gradient
L = Length of contaminated groundwater parallel to the surface water (meters)
3 = Default value for vertical thickness of the source (meters)
C = Conversion factor from m^3/day to cfs (0.00041)

b. Attach:
1. Topographic map with a scale of at least 1:24,000
2. Groundwater contamination maps for chemicals of concern which exceed surface water criteria or applicable acutely toxic levels.

c. Mail to: Water Resources Section, Department of Natural Resources, Wallace Building, Des Moines, IA 50319-0034.

d. DNR staff will complete Section II, and return to the name and address listed under "Requested By:".

e. The groundwater professional may need to convert naphthalene and benz(a)anthracene results to TEH, using the default percentages in Appendix B.

The allowable discharge concentration is the target level which must be met adjacent to the surface water body which is the point of compliance.

The target level for the point of exposure/compliance for general use segments subject to evaluation is the acutely toxic level. If the modeled concentrations or the field data at the point of exposure/compliance exceed the acutely toxic levels, modeling must be used to determine site classification and corrective actions.

3.7.6 Pathway classification

Upon completion of analysis of field data and modeled data, the pathway must be classified high risk, low risk or no further action.

- For general use segments, if the groundwater professional determines there is no sheen or residue present, or if the site is not the source of the sheen or residue, or if the sheen does not consist of petroleum-regulated substances, no further action is required for assessment of this pathway. If a petroleum-regulated substance sheen is present, the pathway is high risk and subject to corrective action.

- For designated use segments, if projected concentrations of chemicals of concern and field data at the point of compliance do not exceed the target level adjacent to the surface water, and the groundwater professional determines there is no sheen or residue present, no further action is required for assessment of this pathway.

3.7.7 Corrective action response

Unless the pathway is classified as no further action, corrective action for this pathway must be conducted. For surface water bodies failing the visual inspection criteria, corrective action must eliminate the sheen, and reduce concentrations to below the site-specific target level.

CHAPTER 4: BEDROCK ASSESSMENT

Prior to conducting any groundwater drilling, a groundwater professional must determine if there is a potential to encounter bedrock before groundwater. These potential areas include

- areas where karst features or outcrops exist in the vicinity
- areas with bedrock less than 50 feet from the surface as illustrated in Appendix ?
- during drilling, bedrock was encountered before groundwater at any monitoring well or boring installed during assessment activities (e.g., tank closure, site check, T1 assessment in progress, previous Site Cleanup Report data). The groundwater professional must take into consideration variations in groundwater elevations in making this determination which is based on the highest groundwater elevation. The highest groundwater elevation is the estimated average of the highest measured groundwater elevations for each year.

The purpose of this determination is to prevent drilling through contaminated subsurface areas thereby creating a preferential pathway to a bedrock aquifer.

If the first encountered groundwater is above bedrock but near the bedrock surface or fluctuates above and below bedrock, the groundwater professional should evaluate the subsurface geology and aquifer characteristics to determine the potential for creating a preferential pathway. If it is determined that the aquifer acts like a non-granular aquifer or if bedrock is encountered before groundwater, special bedrock procedures must be followed.

If the first encountered groundwater is above bedrock with sufficient separation and aquifer characteristics to establish that it acts as a granular aquifer, site assessment may proceed under normal Tier 2 procedures. However, even under this condition, drilling through bedrock should be avoided in contaminated areas.

The owner or operator may choose to proceed directly to a Tier 3 assessment rather than conducting a Tier 2 assessment. A work plan for Tier 3 must be approved by DNR before a Tier 3 assessment can be conducted.

4.1 Categories for Special Bedrock Assessment

For sites where bedrock is encountered before groundwater, there are three general categories that determine which assessment procedures must be used. The categories are based on a determination of whether the groundwater in bedrock acts in a manner consistent with a granular aquifer and if monitoring wells exist at the site. This distinction is necessary due to the difficulties in modeling the behavior of non-granular aquifers and the lack of groundwater source concentration data. The categories are: exempt granular bedrock, granular bedrock and non-granular bedrock. The groundwater professional may use data from existing wells to make the category determinations. If wells do not exist at the site, proceed with definition of the groundwater contamination plume using procedures to prevent the creation of preferential pathways. Groundwater data should be evaluated as it is obtained so that the site categorization may be conducted.

4.1.1 Non-granular Bedrock

Non-granular bedrock is bedrock which is determined to not act as a granular aquifer as provided in Part 2 below. Non-granular bedrock generally has some type of fractured system where groundwater transport modeling cannot be applied and which makes it difficult to define the extent of contamination.

Typically non-granular aquifers exhibit extraordinary variations (i.e., variations in feet) in groundwater elevations. The variations in groundwater elevations occur seasonally as well as spatially and would not be associated with constructed conduits (i.e. storm and sanitary sewers) which could cause dewatering of the aquifer.

Non-granular aquifers also have unusual groundwater flow characteristics which are caused by the fracture patterns and dissolution cavities in the bedrock. This may result in irregular shaped contamination plume or an uneven distribution of the contaminant concentrations.

The hydraulic conductivities obtained in non-granular aquifers are unusually high or extremely variable. The hydraulic conductivity is dependent on the number and size of the fractures intercepted by the screened interval of the monitoring well. For example, wells may recover from slugging at such a rapid rate that it is difficult or impossible to accurately measure a recharge rate. Other wells at the same site may have a very low hydraulic conductivity. The variation in hydraulic conductivity tests is considered significant if they differ by an order of magnitude. The hydraulic conductivity must be determined in a minimum of three wells to document the variability.

The total dissolved solids concentrations in non-granular aquifers are also variable from well to well. A variation in total dissolved solids values greater than 20% between wells is considered significant.

4.1.2 Granular Bedrock

Granular bedrock is bedrock which is determined to act as a granular aquifer and for which monitoring wells do not exist at the source as of August 15, 1996. A granular aquifer is one that shows no extraordinary variations or inconsistencies in: groundwater elevations across the site, groundwater flow, hydraulic conductivities, or total dissolved solid concentrations among monitoring wells. Although the extent of contamination can be defined in granular bedrock, groundwater transport modeling cannot be used because there are no monitoring wells at the source.

4.1.3 Exempt granular bedrock

Exempt granular bedrock is bedrock which is determined to act as a granular aquifer as provided in Part 2 above and for which monitoring wells exist at the source as of August 15, 1996. **Sites in exempt granular bedrock shall be evaluated using the normal Tier 1 or Tier 2 procedures in this rule.** Non-granular bedrock is not exempt from special bedrock assessment even if groundwater monitoring wells exist at the source.

4.2 Special Procedures for Granular and Non-Granular Bedrock—General

4.2.1 Exempt Soil Pathways

Evaluate the soil vapor to enclosed space pathway and the soil to plastic water line pathway under the normal Tier 2 procedures. Avoid the creation of a preferential pathway to groundwater.

4.2.2 Protected Groundwater Source

A protected groundwater source is assumed regardless of measurements of hydraulic conductivity for all sites designated as granular or non-granular bedrock.

4.2.3 Soil Leaching to Groundwater Ingestion Pathway

The vertical and horizontal extent of soil contamination must be defined to Tier 1 levels for the soil leaching to groundwater pathway without drilling into bedrock. The pathway must be evaluated in combination with the groundwater ingestion pathway. Because of the policies requiring soil remediation to the soil leaching to groundwater Tier 1 levels, the soil leaching pathway target levels applicable to other groundwater transport pathways and other soil pathways would not be exceeded. If a soil leaching to groundwater Tier 1 level is exceeded, the pathway is high risk.

4.2.4 Soil Contamination Remediation

For all sites where soil contamination exceeds the soil leaching to groundwater Tier 1 levels, soil excavation or other active soil remediation technology must be conducted to reduce concentrations to below this Tier 1 level. Soil remediation monitoring must be conducted. Refer to soil excavation requirements.

4.2.5 Initial Groundwater Assessment

A minimum of three groundwater monitoring wells must be initially installed between 50 to 100 feet beyond the soil contamination Tier 1 levels using procedures to avoid creating a preferential pathway. The objective of well installation is to identify areas of maximum groundwater contamination and to provide data to determine if the bedrock acts in a granular or non-granular manner. When installing the wells, the groundwater professional must take into consideration groundwater flow direction, other pertinent hydrogeological factors at the site and the location of receptors.

The groundwater professional may use data from existing wells to determine which of the three categories fit the site. If wells do not exist at the site, proceed with definition of the groundwater contamination plume using procedures to prevent the creation of preferential pathways. Groundwater data should be evaluated as it is obtained so the site may be categorized as either granular or nongranular bedrock.

For sites designated as granular bedrock, the groundwater plume must be defined to Tier 1 levels as described for each pathway for a normal Tier 2 assessment.

Groundwater transport models cannot be used with sites designated as granular bedrock because of the lack of groundwater source concentration data. Groundwater transport models cannot be used with sites designated as non-granular bedrock due to the difficulties in modeling the behavior of non-granular aquifers.

The following special procedures for each groundwater pathway must be used for all sites designated as granular or non-granular bedrock.

4.3 Special Procedures for the Groundwater Ingestion Pathway

A protected groundwater source is assumed regardless of measurements of hydraulic conductivity for all sites where bedrock is encountered before groundwater.

4.3.1 Groundwater Plume Definition

For sites designated as granular bedrock, the groundwater plume must be defined to Tier 1 levels as described for each pathway for a normal Tier 2 assessment.

4.3.2 Groundwater Well Receptor Evaluation

All drinking and non-drinking water wells within 1,000 feet of the source must be identified and tested for chemicals of concern. All public water supply systems within one mile of the source must be identified and raw water tested for chemicals of concern. If no drinking water wells are located within 1,000 feet of the source, all the area within 1,000 feet is considered a potential receptor point of exposure. The distance from the source is measured from the well with the maximum BETX combined concentration. If groundwater contamination is not present, the measurements are taken from the location with the maximum soil contamination using BETX combined or TEH concentration.

4.3.3 Target Levels

The following target levels apply regardless of granular aquifer designation. If drinking water wells are within 1,000 feet of the source, the applicable target level is the groundwater ingestion pathway Tier 1 level for actual receptors. If non-drinking water wells are within 1,000 feet of the source, the applicable target level is the groundwater

ingestion pathway Tier 1 level for potential receptors. For potential receptors, the applicable target level is the groundwater ingestion pathway Tier 1 level for potential receptors.

4.3.4 Sentry Well—Only For Sites Designated As Granular Bedrock

If the Tier 1 level for actual receptors is exceeded and the receptor has not yet been impacted, a monitoring well shall be placed between the source and an actual receptor, outside the defined plume and approximately 200 feet from the actual receptor. For alternative well placement, the certified groundwater professional must provide justification and obtain department approval. This monitoring well is to be used for monitoring potential groundwater contamination of the receptor.

4.3.5 High Risk Classification

Sites designated as granular or non-granular bedrock shall be classified high risk for this pathway if any of the following conditions exist:

(A) the target level at any actual receptor is exceeded; or

(B) drinking water well receptors are present within 1,000 feet and groundwater concentrations in any monitoring well exceed the groundwater ingestion Tier 1 level for actual receptors; or

(C) non-drinking water wells are within 1,000 feet and groundwater concentrations in any monitoring well exceed the groundwater ingestion pathway Tier 1 level for potential receptors; or

(D) **Only for sites designated as non-granular bedrock**—groundwater concentrations for chemicals of concern from any public water system well within one mile of the source exceed 40 percent of the Tier 1 level for actual receptors, and groundwater concentrations in any monitoring well exceed the groundwater ingestion Tier 1 level for actual receptors .

Corrective actions (in addition to monitoring) must be undertaken at high risk sites.

4.3.6 Low Risk Classification

Sites without an actual receptor within 1,000 feet shall be classified as low risk for this pathway if no high risk conditions exist, and the Tier 1 level for potential receptors is exceeded. The site is subject to monitoring.

If an actual receptor exists within 1,000 feet, the site shall be classified low risk for this pathway when soil contamination has been removed or remediated to below the soil leaching to groundwater Tier 1 levels, and all groundwater monitoring wells are non-detect or below the applicable target level for actual and potential receptors. A site may be reclassified to no action required for this pathway after all monitoring wells meet the exit monitoring criteria. Exit monitoring is required because groundwater monitoring wells are not located at the source or if they are, the data are highly unreliable given the nature of bedrock.

4.4 Special Procedures for the Groundwater Vapor to Enclosed Space Pathway

4.4.1 Soil Gas Plume

Soil gas measurements must be taken in accordance with section 1.9 of this guidance to determine a soil gas plume. Soil gas where practical should be measured at the soil-bedrock interface. At a minimum, soil gas must be measured at the suspected area of maximum contamination and near the three monitoring wells with the highest concentrations that exceed the Tier 1 level for the groundwater to enclosed space pathway. Where the plume has been defined, soil gas measurements should be taken near wells exceeding the Tier 1 level. Other soil gas measurements must be taken as needed to define the extent of contamination where soil gas measurements exceed the soil gas vapor target levels. Linear interpolation must be used to define the edge of the plume.

The soil gas target level for benzene is 600,000 $\mu g/m^3$ and for toluene is 9,250,000 $\mu g/m^3$.

4.4.2 High Risk Classification

The site shall be classified high risk for this pathway if an actual confined space receptor (e.g., basement or sewer) exists within 50 feet of the soil gas plume based on the soil gas target level.

4.4.3 Low Risk Classification

The site shall be classified as low risk for this pathway if the soil gas exceeds the vapor target level at any point and no actual confined space receptors exist within 50 feet of the soil gas contaminant plume based on the soil gas target level.

4.5 Special Procedures for the Groundwater to Plastic Water Line Pathway

4.5.1 Target Level

The applicable target level is the Tier 1 level for plastic water lines.

4.5.2 High Risk Classification

A site is classified high risk for this pathway if ALL of the following conditions exist:

- the highest groundwater elevation* is higher than three feet below the bottom of a plastic water line; and
- if risk classification cannot be determined due to limitations on placement of monitoring wells, and
- plastic water lines exist within 200 feet of a monitoring well which exceeds the Tier 1 level.

*The highest groundwater elevation is the estimated average of the highest measured groundwater elevations for each year.

4.6 Special Procedures for the Surface Water Pathway

Any surface water body within 200 feet of the source must be evaluated.

4.6.1 Point of Compliance

The monitoring well closest to the surface water body must be used as the point of compliance to evaluate impacts to designated use segments and for surface water that fails the visual inspection. If the surface water criteria is exceeded, an allowable discharge concentration must be calculated and met at the point of compliance. See section 3.7.5 of this guidance for directions in calculating the allowable discharge concentration.

4.6.2 High Risk Classification

The site shall be classified high risk for this pathway if the surface water body is within 200 feet of the source, and any of the following conditions exist:

- the monitoring well closest to the designated use segment exceeds the allowable discharge concentration; or
- the surface water fails the visual inspection; or
- the sheen has been removed from the surface water and the monitoring well closest to the general use segment exceeds the acutely toxic target level.

4.6.3 Low Risk Classification

If the allowable discharge concentration is not exceeded at the point of compliance, the site shall be classified as low risk for this pathway and subject to monitoring. The monitoring well closest to the receptor shall serve as the sentry well for monitoring purposes.

4.7 High Risk Corrective Action Response

Owners and operators have the option to conduct a Tier 3 assessment instead of initiating corrective actions.

4.7.1 Groundwater Ingestion Pathway

For high risk sites, where soil exceeds the soil leaching to groundwater Tier 1 level for actual receptors, soil excavation or other active remediation of soils must be conducted in accordance with department guidance to reduce soil concentrations to below the soil leaching Tier 1 level.

Corrective action other than monitoring of groundwater is required:

- **in non-granular bedrock** if the actual receptor has been or is likely to be impacted.
- **in granular bedrock** if an actual receptor has been impacted or a sentry well has been impacted above Tier 1 levels.

Acceptable corrective actions for impacted or vulnerable groundwater wells may include technological controls, institutional controls, well plugging, relocation, and well reinstallation with construction measures sufficient to prevent contaminant infiltration to the well and to prevent formation of a preferential pathway.

4.7.2 Groundwater Ingestion Pathway High Risk Monitoring

For high risk sites in **non-granular or granular bedrock,** if the soil concentrations do not exceed the soil leaching to groundwater Tier 1 levels or have been reduced to this level by corrective action, and corrective action of groundwater is not required, these sites shall be subject to groundwater monitoring.

Corrective action other than monitoring of groundwater is required at sites designated as **granular bedrock** if groundwater concentrations exceed the applicable target level less than 200 feet from an actual receptor.

Reevaluation of the potential for impact to actual receptors is required at sites designated as **non-granular bedrock** if concentrations from monitoring wells increase more than 20 percent of the previous samples.

4.7.3 Other Pathways

For high risk sites other than groundwater ingestion, active remediation must be conducted to reduce concentrations below the applicable target levels. The use of institutional and technological controls may also be considered.

4.8 Monitoring

For high and low risk sites, annual monitoring at a minimum is required as follows. Sampling events must be separated by at least six months. Potential receptor status for low risk sites must be confirmed. The annual monitoring may be used to meet the exit requirements for a no action required classification.

4.8.1 Groundwater in Non-Granular Bedrock

All groundwater monitoring wells must be monitored at least annually.

4.8.2 Groundwater in Granular Bedrock Designations

The following monitoring wells must be monitored at least annually: a well with detected levels of contamination closest to the leading edge of the groundwater plume between the source and the receptor, and a sentry well with concentrations not detected or below the applicable target level.

4.8.3 Soil Gas

For sites where the soil gas target level is exceeded, annual monitoring of soil gas is required at the suspected area of maximum contamination and between the soil gas plume and any actual receptors within 100 feet of the soil gas plume.

4.9 No Action Required Classification

A site may be given a no action required classification if after conducting a Tier 2 assessment, it is determined the maximum soil concentrations do not exceed the Tier 1 levels for the soil leaching pathway, and the groundwater exit monitoring criteria and soil gas confirmation sampling are met as follows:

4.9.1 Groundwater in Non-Granular Bedrock

Exit monitoring requires that samples from all groundwater monitoring wells must not exceed the applicable target levels for annual sampling for three consecutive sampling events.

4.9.2 Groundwater in Granular Bedrock Designations

Exit monitoring must be met in two ways: (A) a monitoring well between the source (i.e. highest soil contamination concentration) and the receptor must not exceed applicable target levels for three sampling events, and samples must be separated by at least six months; and (B) the three most recent consecutive groundwater samples from a monitoring well between the source and the receptor with detected levels of contamination must show a steady or declining trend and meet the following criteria: the first of the three samples must be more than detection limits, concentrations cannot increase more than 20 percent from the first of the three samples to the third sample; concentrations cannot increase more than 20 percent of the previous sample; and samples must be separated by at least six months.

4.9.3 Soil Gas

Confirmation sampling for soil gas for the enclosed space pathways is required to reasonably establish that the soil gas samples represent the highest expected levels. A groundwater professional must obtain two soil gas samples taken at least two weeks apart, and one of the samples must be taken during a seasonal period of lowest groundwater elevation below the frost line.

4.9.4 Monitoring Well Plugging

All monitoring wells must be properly plugged after receiving a no action required classification.

CHAPTER 5: TIER 2 AND 3 SITE CLASSIFICATION AND CORRECTIVE ACTION RESPONSE.

5.1 Risk Classification

5.1.1 General

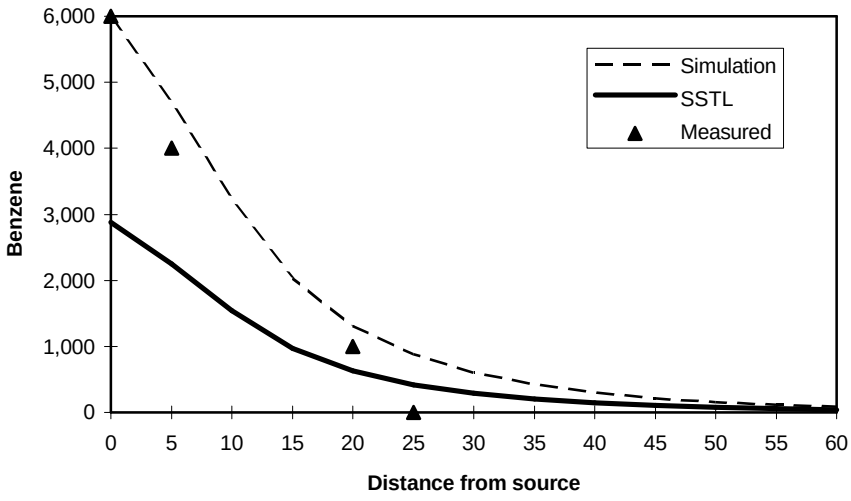
Sites must be classified either high risk, low risk or no action required.

5.1.2 High Risk Classification

A site shall be classified high risk if any pathway is high risk.

Groundwater pathways and the soil leaching pathway are high risk if any actual field data exceeds the site-specific target level line at any point for an actual receptor.

Graph 1: Any Measured Data Above the SSTL Line -- Actual Receptor -- High Risk



Also, the soil leaching pathway is high risk for a potential receptor if both:

- the groundwater ingestion Tier 1 level for potential receptors is exceeded by actual field data AND
- the soil leaching site-specific target level at the source is exceeded by actual field data.

Other soil pathways: The soil vapor to enclosed space and soil to plastic water line pathways are high risk if a target level for an actual receptor is exceeded by actual field data. (A site-specific target level cannot be calculated because there are no horizontal transport models for these soil pathways.)

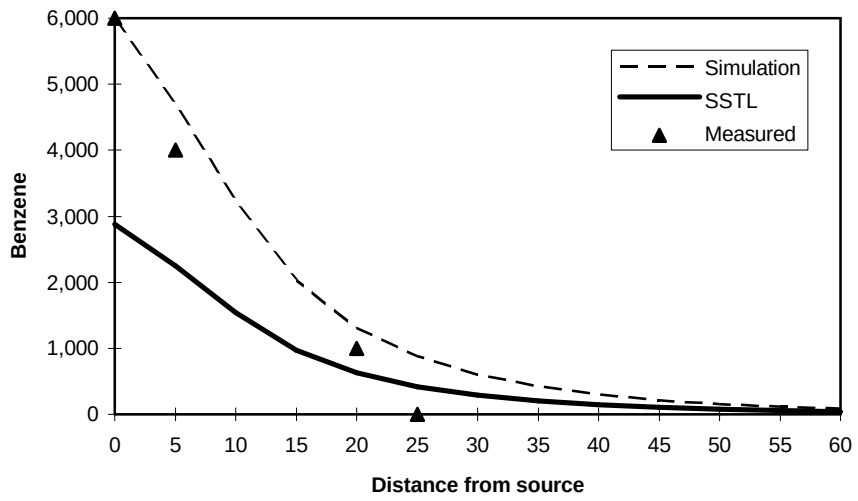
Vapor Pathways: The soil vapor and groundwater vapor to enclosed space pathways are high risk if the explosivity levels at applicable points of compliance are exceeded.

5.1.3 Low Risk Classification

A site shall be classified as low risk if none of the pathways are high risk and if any of the pathways are low risk. A pathway shall be classified low risk if it meets one of the following conditions:

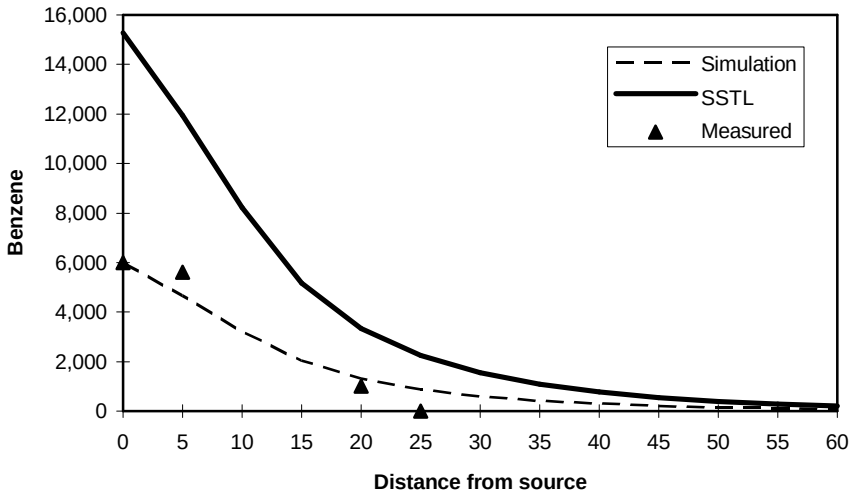
1. For potential receptors, if any actual field data exceeds the site-specific target level line at any point.

Graph 2: Any Measured Data Above the SSTL Line -- Potential Receptor -- Low Risk



2. For actual and potential receptors, if the modeled data and the actual field data are less than the site-specific target level line, and any of the field data is greater than the simulation line.

Graph 3: All Data Below the SSTL Line & Any Measured Data Above the Simulation Line-- Actual or Potential Receptor -- Low Risk



3. The soil leaching pathway shall be initially classified as low risk and subject to a minimum of three years of annual groundwater monitoring, if:
   - modeling predicts the groundwater ingestion Tier 1 level for potential receptors would be exceeded by actual field data, but current data does not exceed it and
   - the soil concentration exceeds the soil leaching to groundwater site-specific target level.

   If groundwater concentrations are below the applicable SSTL line for all three years and a final soil sample taken from the source area shows no significant vertical movement, no further action is required. If groundwater concentrations exceed the applicable SSTL line in any of the three years, corrective action is required to reduce soil concentrations to below the Tier 1 levels for soil leaching to groundwater. If at any time during the three-year monitoring period, groundwater concentrations exceed the Tier 1 level for potential receptors, the site shall be classified as high risk requiring soil remediation.

5.1.4 No Action Required Classification

A site shall be classified as no action required if all of the pathways are classified as no action required as provided below:

Soil pathways shall be classified as no action required if samples are less than the applicable target levels as defined for each pathway and confirmational sampling requirements have been met.

For initial classification, groundwater pathways shall be classified as no action required if the field data is below the site-specific target level line and all field data is at or less than the simulation line, and confirmation monitoring has been completed successfully. Confirmation sampling for groundwater and soil is a second sample which confirms the no action required criteria.

For reclassification from high or low risk, a pathway shall be classified as no action required if all field data is below the site-specific target level line and if exit monitoring criteria have been met. Exit monitoring criteria means the three most recent consecutive groundwater samples from all monitoring wells must show a steady or declining trend and the most recent samples are below the site-specific target level line. Other criteria include the following:

- the first of the three samples for the source well and transition well must be more than detection limits;
- concentrations cannot increase more than 20 percent from the first of the three samples to the third sample;
- concentrations cannot increase more than 20 percent of the previous sample; and
- samples must be separated by at least six months.

Confirmation sampling for soil gas and indoor vapor. For the enclosed space pathways, confirmation sampling is required to reasonably establish that the soil gas and indoor vapor samples represent the highest expected levels. A groundwater professional must obtain two samples taken at least two weeks apart. One of the samples must be taken during a seasonal period of lowest groundwater elevation and soil gas samples must be taken below the frost line.

Upon site classification as no action required, all groundwater monitoring wells must be properly plugged in accordance with 567-Chapters 39 and 49 (available from the IDNR Records Section at 515/242-5818) unless the department requires selected wells to be maintained or written approval to maintain the well is obtained by the department.

5.1.5 Reclassification

Any site or pathway which is classified as high risk may be reclassified to low risk if in the course of corrective action the criteria for low risk classification are established. Any site or pathway which is classified as low risk may be reclassified to high risk if in the course of monitoring the conditions for high risk classification are established. Sites subject to department-approved institutional or technological controls are classified as no action required if all other criteria for no action required classification are satisfied.

5.2 High Risk Corrective Action Response

5.2.1 Objectives

The primary objectives of corrective action in response to a high risk classification are both short-term and long-term. The short-term goal is to eliminate or reduce the risk of exposure at actual receptors which have been or are imminently threatened with exposure above target levels. The longer term goal is to prevent exposure to actual receptors which are not currently impacted or are not imminently threatened with exposure. To achieve these objectives, concentrations of applicable chemicals of concern must be reduced by active remediation to levels below the site-specific target level line at all points between the source(s) and the point(s) of exposure as well as to undertake such interim corrective action as necessary to eliminate or prevent exposure until concentrations below the SSTL line are achieved. If it is shown that concentrations at all applicable points have been reduced to below the SSTL line, the secondary objective is to establish that the field data can be reasonably relied upon to predict future conditions at points of exposure rather than reliance on the modeled data. Reliance on field data is achieved by establishing through monitoring that concentrations within the contaminant plume have stabilized or are declining. Use of institutional controls and technological controls may be used to sever pathways or control the risk of receptor impacts.

For the soil vapor and soil to plastic water line, these objectives are achieved by active remediation of soil contamination below the target level at the point(s) of exposure or other designated point(s) of compliance.

For a site classified as high risk or reclassified as high risk for the soil leaching to groundwater ingestion pathway, corrective action consists of active remediation of the soil contamination to concentrations below the site-specific target level at the source.

5.2.2 Corrective Active Design Report

The Corrective Active Design Report (CADR) must be submitted by a certified groundwater professional for all high risk sites. The CADR must be submitted on a form provided by the department and in accordance with department CADR guidance within 120 days of site classification approval. The CADR must identify at least two applicable corrective action options, an outline of the projected timetable and critical performance benchmarks, a specific monitoring proposal designed to verify its effectiveness and provide sufficient supporting documentation consistent with industry standards that the technology is effective to accomplish site-specific objectives. The CADR must contain an analysis of its cost effectiveness in relation to other options.

The certified groundwater professional responsible for completion of the CADR must sign the certification statement on the cover sheet.

A submitted CADR is considered to be complete if it contains all the information and data required by the department's administrative rules and guidance. The report is considered accurate if the information and data are reasonably reliable based first on the standards in these rules and department guidance, and second, on generally accepted industry standards. Unless the report proposes to classify the site as no action required, the department must approve the report within 60 days for purposes of completeness or disapprove the report upon a finding of incompleteness, inaccuracy or noncompliance with these rules. If no decision is made within this 60-day period, the report is deemed to be approved for purposes of completeness. The department will review each CADR which proposes to classify a site as no action required to determine the data and information are complete and accurate, the data and information comply with department rules and guidance and the site classification proposal is reasonably supported by the data and information.

5.2.3 Interim monitoring

From the time a Tier 2 site cleanup report is submitted and until the department determines a site is classified as no action required, interim monitoring is required at least annually for all sites classified as high risk. Refer to the

section below on Annual Monitoring. Monitoring conducted as part of remediation or as a condition of establishing a no action required classification may be used to the extent it meets this criteria.

5.2.4 Remediation monitoring

Remediation monitoring during operation of a remediation system is required at least four times each year to evaluate effectiveness of the system. A remediation monitoring schedule and plan must be specified in the corrective action design report and approved by the department.

5.2.5 Technological controls

The purpose of a technological control is to effectively sever a pathway by use of technologies such that an applicable receptor could not be exposed to chemicals of concern above an applicable target risk level. Technological controls are an acceptable corrective action response either alone or in combination with other remediation systems. The purpose of technological controls may be to control plume migration through use of containment technologies, barriers, etc., both as an interim or permanent corrective action response or to permanently sever a pathway to a receptor. Controls may also be appropriate to treat or control contamination at the point of exposure. Any technological control proposed as a permanent corrective action option without meeting the reduction in contaminant concentrations objectives must establish that the pathway to a receptor will be permanently severed or controlled. The effectiveness of a technological control must be monitored under a department approved plan until concentrations fall below the site-specific target level line or its effectiveness as a permanent response is established, and no adverse effects are created.

5.2.6 Completion of Corrective Action

Following completion of corrective action, the site must meet exit monitoring criteria to be reclassified as no action required. At any point where an institutional or technological control is implemented and approved by the department, the site may be reclassified as no action required.

5.3 Low Risk Corrective Action Response.

For sites or pathways classified as low risk, the purpose of monitoring is to determine if concentrations are decreasing such that reclassification to no action required may be appropriate or if concentrations are increasing above the site-specific target level line such that reclassification to high risk is appropriate. Monitoring is necessary to evaluate impacts to actual receptors and assess the continued status of potential receptor conditions. Low risk monitoring shall be conducted and reported by a certified groundwater professional.

For sites or pathways classified as low risk, provide a best management practices plan. The plan must include maintenance procedures, schedule of activities, prohibition of practices, and other management practices, or a combination thereof, which, after problem assessment, are determined to be the most effective means of monitoring and preventing additional contamination of the groundwater and soil. The plan will also contain a contamination monitoring proposal containing sufficient sampling points to ensure the detection of any significant movement or increase in contaminant concentration.

5.4 Annual Monitoring

5.4.1 Groundwater Monitoring

For groundwater pathways, samples must be taken at a minimum of once per year:

1. from a monitoring well at the maximum source concentration;
2. a transitional well: a well with detected levels of contamination closest to the leading edge of the groundwater plume as defined to the pathway-specific target level and between the source and the receptor; and

3. a guard well: a monitoring well between the source and the point of exposure with concentrations below the SSTL line.

5.4.2 Soil Monitoring

For the soil vapor to enclosed space pathway potential receptors, soil gas samples must be taken at a minimum of once per year in the area(s) of expected maximum vapor concentrations where an institutional control is not in place.

For the soil leaching to groundwater pathway potential receptors, annual groundwater monitoring is required for a minimum of three years as described above.

For the soil to plastic water line pathway potential receptors, notification of the utility company is required. Notification will result in reclassification to no action required. Therefore, annual monitoring of soil is not applicable.

5.4.3 Other Monitoring Requirements

Receptors must be evaluated at least annually to ensure no actual or modeled data are above the site-specific target level line for any actual receptors. Potential receptor areas of concern must be evaluated at least annually and the presence of no actual receptors confirmed. If actual receptors are present or reasonably expected to be brought into existence, the owner or operator must report this fact to the department as soon as practicable.

The site or pathway must meet exit monitoring criteria to be reclassified as no action required. If concentrations for actual receptors increase above the site-specific target level line or potential receptor status changes to actual receptor status, the site must be reclassified as high risk and further corrective action required.

5.5 Use of Institutional and Technological Controls

Purpose. The purpose of an institutional control is to restrict access to or use of property such that an applicable receptor could not be exposed to chemicals of concern for as long as the target level is exceeded at applicable points of exposure and compliance. Institutional controls include:

1. A law of the United States or the state;
2. A regulation issued pursuant to federal or state laws;
3. An ordinance or regulation of a political subdivision in which real estate subject to the institutional control is located;
4. A restriction on the use of or activities occurring at real estate which are embodied in a covenant running with the land which contains a legal description of the real estate in a manner which satisfies Iowa Code section 558.1 et seq., is properly executed, in a manner which satisfies Iowa Code section 558.1 et seq., is recorded in the appropriate office of the county in which the real estate is located, adequately and accurately describes the institutional control; and is in the form of a covenant as set out in Appendix E or in such a manner reasonably acceptable to the department;
5. Any other institutional control the owner or operator can reasonably demonstrate to the department will reduce the risk from a release throughout the period necessary to assure that no applicable target level is likely to be exceeded.

Modification or termination of institutional and technological controls. At a point when the department determines that an institutional or technological control has been removed or is no longer effective for the purpose intended, regardless of the issuance of a no further action certification or previous site classification, it may require owners and operators to undertake such reevaluation of the site conditions as necessary to determine an appropriate site classification and corrective action response. If the owner or operator is in control of the affected property, the department may require reimplementation of the institutional or technological control or may require a Tier 2 assessment of the affected pathway(s) be conducted to reevaluate the site conditions and determine alternative

corrective action response. An owner or operator subject to an institutional or technological control may request modification or termination of the control by conducting a Tier 2 assessment of the affected pathway or conduct such other assessment as required by the department to establish that the control is no longer required given current site conditions.

If the owner or operator is not in control of the affected property or cannot obtain control and the party in control refuses to continue implementation of an institutional control, the department may require the owner or operator to take such legal action as available to enforce institution of the control or may require the owner or operator to undertake a Tier 2 assessment to determine site classification and an alternative corrective action response. If a person in control of the affected property appears to be contractually obligated to maintain an institutional or technological control, the department may, but is not required to, attempt enforcement of the contractual obligation as an alternative to requiring corrective action by the owner or operator.

If a site is classified no action required, subject to the existence of an institutional control or technological control, the holder of the fee interest in the real estate subject to the institutional control or technological control may request, at any time, that the department terminate the institutional control or technological control requirement. The department shall terminate the requirement for an institutional control if the holder demonstrates by completion of a Tier 2 assessment of the applicable pathway or other assessment as required by the department that the site conditions warranting the control no longer exist and that the site or pathway has met exit criteria for no action required classification.

5.6 Soil Excavation

Excavation for the purpose of removing contaminated soil which exceeds the applicable target levels is permissible for the soil leaching to groundwater pathway, soil vapor to enclosed space pathway, and soil to plastic water line pathway. Additionally, excavation is a permissible corrective action to address soil contamination as provided in section 4.2.2 under the special bedrock procedures. Prior to excavation, field screening must be conducted to estimate the extent of soil contamination.

The excavation must remove the area of soil with concentrations above the target levels for the affected pathway. If excavation is conducted, additional soil sampling is necessary to demonstrate that after excavation the remaining soil concentrations do not exceed the target levels for the affected pathway. At a minimum, one soil sample must be collected for **field screening** every 100 square feet of the base and sidewalls of the excavated area. Field screening shall include the use of a photoionization detector (PID), flame ionization detector (FID), or another similar vapor analyzer, and visual and olfactory observations. Observations and vapor screening results must be documented. Soil samples must be collected for **laboratory analysis** from points indicated by high vapor readings (greater than 10 ppm), or observed contamination, and at least one soil sample collected for every 400 square feet of the base and sidewalls of the excavated area. At a minimum, one sample from each sidewall and the base of the excavation must be collected and analyzed. Samples for laboratory analysis shall be collected from not more than one foot into the base and sidewalls of the excavated area.

All samples shall be shipped to a certified laboratory within 72 hours of collection. Samples shall be refrigerated and protected from freezing during shipment to the laboratory. The soil samples must be analyzed for benzene, toluene, ethylbenzene, and TEH in accordance with 135.16.

Excavated contaminated soils must be properly disposed in accordance with 567--Chapters 100, 101, 102, 120, and 121. If land application of petroleum contaminated soils is used as a means of treatment, a notification for land farming (DNR Form 542-1384) must be submitted to the department prior to land applying the contaminated soil. This form may be obtained by calling 515/242-6492.

A report of the excavation must be provided as an appendix to the Tier 2 report. The report must include the following:

1. Results of field screening.
2. Copies of the analytical data obtained from the soil samples.
3. A scaled site diagram with the following illustrated:
   - area of the original contamination,
   - dimensions and limits of the excavation,
   - field screening sampling locations,
   - location of soil samples submitted for laboratory analysis,
   - groundwater sampling borehole and well locations,
   - pertinent site features such as buildings, roads, utilities, etc.,
   - groundwater flow direction.

5.7 Replacement / Relocation of Plastic Water Lines

Replacing or relocating plastic water lines currently located within or 10 feet beyond the soil plume, or within the actual or modeled groundwater plume are acceptable corrective actions for the groundwater to plastic water line pathway and soil to plastic water line pathway. Prior to replacing or relocating plastic water lines, the utility company which supplies water service to the area must be contacted and give approval for such activities. If the plastic water lines are to be replaced, a non-plastic material must be used (copper, cast iron, etc.). If the plastic water lines are to be relocated, they must be placed beyond 200 feet of the contamination source(s). An adequate investigation of the relocation area must be conducted to assure the lines are not placed into contaminated soil or groundwater. A file search and pedestrian survey are recommended to determine whether there are other UST or LUST sites in the area of pipe relocation.

A report of the water line replacement / relocation activities must be provided as an appendix to the Tier 2 report. The report must include the following:

1. Documentation of authorization from the utility company which supplies water service to the area.
2. If the plastic water lines were replaced, identification of the replacement material, backfill material, and burial depth of reconstructed water line(s).
3. If the plastic water lines were relocated, identification of the backfill and burial depth of the relocated lines, and a brief description of the efforts taken to assure the new location was not contaminated.
4. A scaled site diagram with the following illustrated:
   - pertinent site features such as buildings, roads, utilities, etc.,
   - soil and groundwater contamination in relation to the plastic water line(s) prior to replacement / relocation,
   - if the plastic water lines were relocated, the location of the new lines (an additional map with appropriate scale to show the new location of the lines may be necessary)

5.8 Monitoring Certificates and No Further Action Certificates

5.8.1 Monitoring certificate

The department will issue a monitoring certificate to the owner or operator of an underground storage tank from which a release has occurred, the current property owner, or other responsible party who has undertaken the corrective action warranting issuance of the certificate. Sites classified as low risk or sites classified as high risk monitoring shall be eligible for a monitoring certificate. The monitoring certificate will be valid until the site is reclassified to a high risk requiring active remediation or no action required site. A site which has been issued a monitoring certificate shall not be eligible to receive a certificate evidencing completion of remediation until the site is

reclassified as no action required. The monitoring certificate will be invalidated and the site reclassified to high risk if it is determined by the department that the owner of the site is not in compliance with the requirements specified in the monitoring certificate.

5.8.2 No further action certificate

The department will issue a no further action certificate to an owner or operator of an underground storage tank from which a release has occurred, the current property owner, or other responsible party who has undertaken the corrective action warranting classification of the site as no action required. The person requesting the certificate shall provide the department with an accurate legal description of the property on which the underground storage tanks are or were formerly located. The following conditions apply:

(1) The site has been determined by a certified groundwater professional to not present an unreasonable risk to the public health and safety or the environment;

(2) A person issued the certificate or a subsequent purchaser of the site cannot be required to perform further corrective action solely because action standards are changed at a later date. Action standards refer to applicable site-specific standards when the certificate was issued;

(3) The certificate shall not prevent the department from ordering remediation of a new release or a release of a regulated substance from an unregulated tank;

(4) The certificate will not constitute a warranty of any kind to any person as to the condition, marketability or value of the described property;

(5) The certificate shall reflect any institutional control utilized to ensure compliance with any applicable Tier 2 level; and may include a notation that the classification is based on the fact that designated potential receptors are not in existence;

(6) The certificate shall be in a form which is recordable in accordance with Iowa Code section 558.1 et seq. and substantially in the form as provided in Chapter 135, Appendix D.

The department shall modify any issued no further action certificates containing institutional controls once the owner, operator or their successor or assign has demonstrated that the institutional control is no longer necessary to meet the applicable Tier 2 level.

5.9 Tier 3 Site Assessment Policy and Procedure

Unless specifically limited by rule or an imminent hazard exists, an owner or operator may choose to prepare a Tier 3 site assessment as an alternative to completion of a Tier 2 assessment or as an alternative to completion of a corrective action design report. Prior to conducting a Tier 3 site assessment, the groundwater professional must submit a work plan to the department for approval. The work plan must contain an evaluation of the specific site conditions which justify the use of a Tier 3 assessment, an outline of the proposed Tier 3 assessment procedures and reporting format and a method for determining a risk classification consistent with the policies underlying the risk classification system in 135.12(455B). Upon approval, the groundwater professional may implement the assessment plan and submit a report within a reasonable time designated by the department.

A Tier 3 assessment may include but is not limited to the use of more site-specific or multidimensional models and assessment data, methods for calibrating Tier 2 models to make them more predictive of actual site conditions, and more extensive assessment of receptor construction and vulnerability to contaminant impacts. If use of Tier 2 models is proposed with substitution of other site-specific data (as opposed to the Tier 2 default parameters), the

groundwater professional must adequately justify how site-specific data is to be measured and why it is necessary. The groundwater professional must demonstrate that the proposal has a proven applicability to underground storage tank sites or similar conditions or has a strong theoretical basis for applicability and is not biased toward underestimating the assessment results. The Tier 3 assessment report must include a recommendation for site classification as high risk, low risk or no action required. If a corrective action is required the Tier 3 assessment report must propose at least two corrective action response technologies and provide justification consistent with the standards and policies underlying risk classification and corrective action response found elsewhere within this guidance manual.

The department will review the Tier 3 assessment for compliance with the terms of the approved work plan and principles of the RBCA process. Upon approval of the Tier 3 assessment, the department may require corrective action.

CHAPTER 6: DIRECTIONS FOR COMPLETING THE TIER 2 REPORT FORM

Refer to the Tier 1 Guidance for instructions on completing a Tier 1 assessment. This information must be included in the Tier 2 report as outlined below.

To the extent practicable, during the preparation of the Tier 2 report, use generally available hydrologic, geologic, topographic, and geographic information in an attempt to minimize site-specific testing. In many instances, an area is provided in the Tier 2 report form to record a response. A response must be provided for all questions unless directed otherwise in the instructions. However, please try to limit the response to the area provided. If an expanded response is required, reference it as an attachment.

6.1 Summary Pages

6.1.1 Cover Page

Fully complete the cover page of the Tier 2 Site Cleanup Report including signatures of the responsible party and certified groundwater professional. All groundwater and soil data obtained during the Tier 2 field assessment must be collected by or under the supervision of a certified groundwater professional. The street address is sufficient for site identification purposes. If a rural route, box number or street without a house number is used, then a legal description must be provided using the township, range, and ¼, ¼, ¼, ¼ section. If a no further action certificate is requested, an accurate legal description of the site, as found in the deed or mortgage, must be provided. The legal description may be submitted as an attachment if the space provided on the cover page is insufficient.

6.1.2 Tier 1 Site Data Summary

Complete the Tier 1 Site Data Summary as explained in the Tier 1 Guidance. If a Tier 1 report has been submitted to DNR and changes or corrections have occurred since that submittal, those changes and corrections should be made with a notation explaining the changes. If a Tier 2 report is required due to free product or other conditions, please complete this page anyway.

6.1.3 Tier 1 Pathway Evaluation Summary

Complete the Tier 1 Pathway Evaluation Summary as explained in the Tier 1 Guidance. Corrective actions selected on this page must meet the Tier 1 guidelines. If corrective actions have been completed since submission of the Tier 1 report to DNR and those actions meet Tier 1 guidelines, they should be noted on this page. If corrective actions have been selected that only meet Tier 2 guidelines, then a Tier 2 assessment must be completed for that pathway, and the corrective actions should be noted on page 4-5 in the Tier 2 Receptor Summary.

For example, consider plugging drinking water wells, a possible corrective action for the groundwater ingestion pathway for actual receptors. At Tier 1, drinking water wells within 1,000 feet must be plugged to meet no action requirements. At Tier 2, only drinking wells within the receptor plume must be plugged.

6.1.4 Tier 2 Receptor Summary

Complete the Tier 2 Receptor Summary for each receptor required to be evaluated as described in section 6.6. The pathway assessment in section 6.6 must be completed using computer software before the Tier 2 Receptor Summary can be completed.

- Record the name of each receptor in the appropriate pathway section.
- Put an X in either the "A" box for an actual receptor or the "P" box for a potential receptor.
- For each chemical in Group 1, label the risk classification at the time of initial Tier 2 evaluation (before any corrective actions are implemented as shown in the "Corrective Action(s) Selected" column). Use "H" for high risk, "L" for low risk and "N" for no further action. A risk classification must be determined for each group 1 chemical using the computer software. Supporting documentation (i.e. maps, SSTL tables and graphs) may not be required for each chemical, depending on the pathway assessment as described in section 6.6.

- Repeat for TEH diesel and waste oil if those chemicals were required to be analyzed.
- The "C" column refers to confirmation sampling. Confirmation sampling is required for soil pathways with a no further action classification and for groundwater pathways with an initial no further action classification. Refer to section 5.1.4. Put an X in this column if confirmation sampling has been successfully completed for that receptor.
- For "Corrective Action(s) Selected" use the numbers from the list of corrective actions at the bottom of the page to indicate the recommended corrective actions. Underline the numbers of the corrective actions which have been completed. Documentation for all corrective actions must be included in an appendix as described in section 6.11.
- For "Current Risk", label the risk classification for the receptor, based on the corrective actions that have been completed at the time of report submittal. Use "H" for high risk, "L" for low risk and "N" for no further action.
- If it is recommended to go to Tier 3 for further assessment, put an X in the "Go To Tier 3" box.

Every receptor which is listed for any groundwater pathway must also be listed in the Soil Leaching to Groundwater pathway on page 5.

Extra rows at the bottom of page 5 may be used for additional receptors which may not fit on page 4; please label the pathway for these receptors. Pages 4 and 5 may be copied as needed to accommodate all receptors.

If a No Action Required classification is being requested, all corrective actions and any applicable confirmation sampling or exit monitoring must be completed.

6.2 Sampling Requirements

- Record the soil and groundwater sampling results for the Tier 1 and 2 investigations on page 10. Include previous sampling data (e.g. tank closures, phase 2 investigations, etc.).
- Field Screening Results for only the Tier 2 investigation needs to be recorded on page 9.
- The Soil Gas Analytical Data table on page 11 must include all soil gas analyses.
- The Indoor Vapor Analytical Data table on page 12 must include all indoor vapor analyses.
- Data for Groundwater Flow Direction Map: This table must be completed as described in the report.

Refer to Tier 1 Guidance and Chapter 1 of Tier 2 Guidance for information on sampling requirements. In addition, at Tier 2, generally the contamination plume needs to be defined as described in Chapters 2 and 3.

6.3 Receptor Survey

Please refer to Chapter 3 for additional information concerning the scope of the surveys required to identify receptors. The Tier 1 Receptor Maps (including Well Survey Map, Enclosed Space and Conduit Map and Surface Water Map) must be updated to show any additional receptors identified during the Tier 2 assessment.

Water Well Survey: Active, abandoned and plugged groundwater wells must be identified. Groundwater professionals must differentiate between wells which are drinking water wells and wells which are non-drinking water wells. A drinking water well is any groundwater well used as a source for drinking water by humans and any groundwater well used primarily for the final production of food or medicine for human consumption in facilities routinely characterized with the Standard Industrial Codes (SIC) group 283 for drugs and group 20 for food and kindred products. The Research and Information Services Division of Iowa Workforce Development in Des Moines may be contacted at 515/281-8178 or 1-800-532-1249 (within Iowa) to verify an SIC code for a facility. A non-drinking water well is any groundwater well not defined as a drinking water well including a groundwater well which is not properly plugged in accordance with department rules in 567--Chapters 39 and 49. One exception is an extraction well used as part of a remediation system. Extraction wells are neither drinking water wells nor non-drinking water wells, and are not considered in the pathway evaluation.

Well information readily available from public entities [i.e., county health or zoning departments, IDNR Water Supply Section (515/242-6128), Geological Survey Bureau (GSB) (319/335-1575), etc.] and water well owners must be reported. Copies of IDNR form 542-1226 for wells plugged in accordance with chapter 567--39 of the IAC must be provided. Copies may be obtained from the county assessor's office or the IDNR Water Supply Section.

Enclosed Spaces and Conduits: Buildings, enclosed spaces (basements, crawl spaces, utility vaults, etc.), and conduits (gravity drain lines, sanitary and storm sewer mains and service lines, plastic water lines and other utilities) must be identified. Plastic drinking water lines (***mains and service lines***) must be identified and evaluated. A description of the following must be provided for each conduit and enclosed space: construction material, conduit backfill material, slope of conduit and trench (include flow direction for sewers), burial depth of utility or confined space, and relationship to groundwater levels.

An explosive vapor survey is required in areas where the buildup of explosive vapor levels could occur such as, but not limited to, basements, crawl spaces and utility access ways. The purpose of the explosive vapor survey is to identify conditions immediately hazardous. If explosive vapor levels are identified (concentrations of combustible gases exceeding 10% of the Lower Explosive Limit [LEL]), the groundwater professional must notify the tank owner or operator or a party reasonably believed to be responsible for reporting the contamination with instructions to report the condition in accordance with Chapter 567-131. The owner or operator must begin immediate response and abatement procedures in accordance with 135.7 and Chapter 567-133. The situation will be handled under IDNR's Emergency Response protocols.

An explosive vapor survey may not be necessary in all cases; however, adequate justification for not conducting the survey must be provided (e.g., buildings, confined spaces or utility access ways are not located within 500 feet, Tier 1 levels for the pathway are not exceeded, etc.).

An explosive vapor survey must be conducted at sites where reports of vapors have been received, or there are indications that contamination is or is likely to be in contact with occupied structures or utilities. Records filed with the Emergency Response Section and the Underground Storage Tank Section of the IDNR, State Fire Marshall's Office, County Health Department, and the local police and fire department should be examined to determine whether any vapor problems have been reported in the area.

Explosive Vapor Survey. The following procedures are recommended when conducting an explosive vapor survey:

1. An explosimeter must be used to take vapor readings.
2. Start at the utility access way nearest to the site. Work upstream and downstream to determine whether vapors are present, where vapors may be entering, and the extent of impacted area.
3. "Crack" each utility access cover and take readings for oxygen and percentage explosion level. Repeat measurements at mid-depth and water level or bottom of conduit.
4. Check air flow directions to determine if dilution of vapors is occurring.
5. Check lift stations near the site.
6. Check confined spaces and occupied structures. Record the names and addresses of buildings, residences and owners.
7. Check for vapors in basements, sewer drains, and near any foundation cracks.

Surface Water Bodies: Surface water bodies include both general use segments and designated use segments as defined in 567-61.3(1) of the IAC. All surface water bodies (i.e., lakes, ponds, rivers, streams, intermittent stream beds, drainage ditches, etc.) must be identified and visually inspected for a sheen on the water surface, and residues along a stream bank or bed. The following procedures are recommended when conducting a visual inspection for petroleum residue along a stream bank or in an intermittent stream bed:

If the surface water is a designated use segment, list all classifications in the Surface Water Survey table. If the surface water is not a designated use segment, it is considered a general use segment. (Refer to Appendix G: Selections from Chapter 61 Water Quality Standards.)

Stream bank:

1. Look for bare soil areas along the lower bank where the seep of petroleum products may be surfacing and killing vegetation.
2. During the growing season, look for dead or dying vegetation along or below the high-water mark. Inspect the dead vegetation to determine whether death was caused naturally or by coating with petroleum residues. The residues usually will cause localized portions of the plant to be stressed or to die. A coating of slightly shiny, brown/black dirt-type particles (the mixture of petroleum products and the suspended/floating material found in the stream) may occur on the vegetation. The dead or dying vegetation will likely be in small patches or clumps, not large expanses as would occur if the vegetation were dying from being inundated for a long time.

Stream bed:

1. Similar to the vegetation coating but potentially more evident; a shiny-spongy brown/black dirt-type coating may occur on the material found along a previous water line.
2. Also look in the areas that become isolated pools when the stream no longer flows. The petroleum residue will tend to accumulate in these isolated pools, coating the stream bed material including branches, rocks and debris.

If a sheen or residue is evident or has been reported to be present, the groundwater professional must make a sufficient investigation to reasonably determine its source. If, in the opinion of the groundwater professional, the sheen is not associated with the underground storage tank site, an adequate justification must be provided. If, in the opinion of the groundwater professional, the sheen is not a petroleum-regulated substance, a sample must be laboratory analyzed using Iowa Methods OA-1 and OA-2 and in accordance with 135.16 to confirm it is not a petroleum-regulated substance.

6.4 Affected Property Owner Table

The department has the responsibility of notifying landowners affected or with the potential to be affected by the petroleum release. Provide a table which includes all properties in any receptor plume which contains a receptor classified as high or low risk. This includes properties considered potential receptors. (Refer to section 6.6 for further information on determining a receptor plume.) The property address, owner and the mailing address of the owner (including the zip code) must be provided. Include the owners of rights-of way in the table. Be sure the property owner names in the table correspond with the numbers used on the Landowner Map.

6.5 Off-site Contamination Source Discussion

If, during the course of the Tier 2 assessment, contamination identified is attributable to an off-site source, provide a detailed justification for any conclusions concerning off-site contamination sources. Include in the justification: analytical data, maps showing the site under investigation and the off-site source and groundwater flow directions. Sufficient justification must be based on factors other than the past use of the off-site property (i.e., it used to be a gas station).

6.6 Pathway Assessments

6.6.1 Groundwater Pathway Assessment

The following procedures should be followed **FOR EACH GROUNDWATER RECEPTOR TYPE**, including:

1. Groundwater ingestion—actual
2. Groundwater ingestion—potential
3. Groundwater vapor to enclosed space—confined space—residential
4. Groundwater vapor to enclosed space—confined space—nonresidential
5. Groundwater vapor to enclosed space—sanitary sewer—residential
6. Groundwater vapor to enclosed space—sanitary sewer—nonresidential
7. Groundwater to plastic water line
8. Surface water

I. **Develop a receptor plume map.** This is one map for each receptor type with overlapping modeled plumes. It should show all receptors for the receptor type and the simulated plumes as described below.

A. Starting with benzene:

1. Identify the monitoring well with the maximum benzene concentration: the source well.
2. Use the computer to
   a. Generate a simulated plume for benzene and
   b. Calculate the simulated value for each monitoring well.
   c. Identify any monitoring wells where the measured concentration exceeds the simulated concentration. These are alternate source wells.
   d. Generate another simulated plume for each alternate source well, using the alternate source well as the source. Use the same source width (S_w) for all simulations. (This is the only situation the alternate source well will be used. It will NOT be used to generate SSTL lines, only to generate a receptor plume map.) Using alternate source wells accounts for situations where the actual plume exceeds the simulated plume. Therefore the receptor plume map is substituted for any requirements referring to "the simulated plume, or if the actual plume exceeds the simulated plume, then the actual plume plus ten percent."

B. Repeat this process for all wells which contain free product, because they would also be considered source wells.

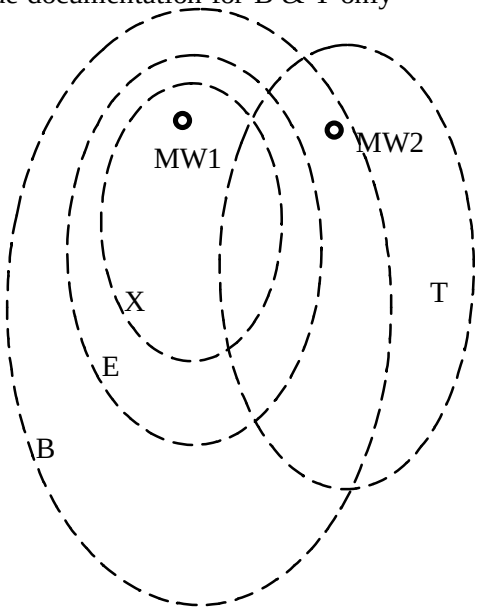
C. Repeat this process for each chemical of concern, using the monitoring well with the maximum concentration for that chemical as the source well. All modeled plumes for the different chemicals of concern will be on one map for each receptor type.

D. The receptor plume map will be used for two purposes:

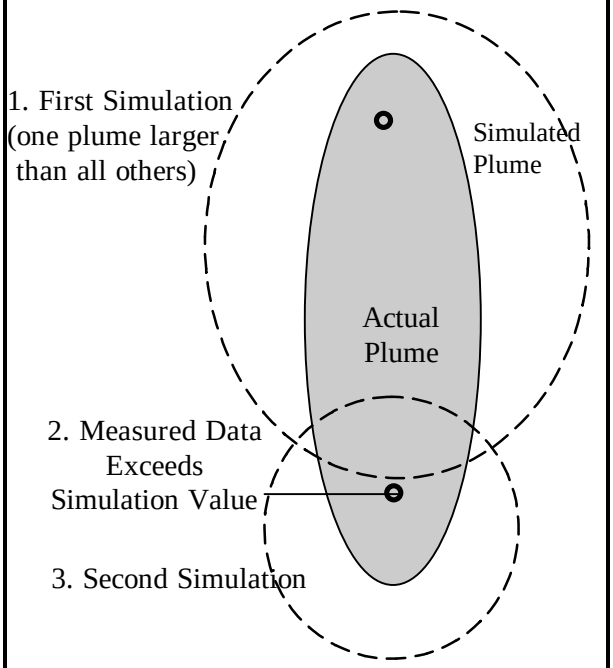
1. Identify receptors which must be evaluated. All receptors within this receptor plume must be evaluated.
2. Determine which chemical(s) require documentation to be printed in the report. This includes maps, SSTL graphs, and SSTL tables. (Although some chemicals may not require printed documentation, the computer will generate SSTLs which must still be met.)
   a. If one chemical's plume map encompasses all other plume maps, that is the only map and the only SSTL graphs and SSTL tables that must be included in the report.
   b. If a chemical's plume map covers an area that is not covered by any other chemical's plume map:
      1. That chemical's plume map must be included for the applicable pathway.
      2. Any receptors located in that unique area must have an SSTL graph and SSTL table developed for that chemical and included in the report.
3. On the **Tier 2 Report Checklist** (pages 6-7), check the boxes for the chemicals which require documentation in the report as determined above.

E. Repeat this procedure to develop a receptor plume map for the **soil leaching** to each of the groundwater receptor types. Use the boring with the maximum soil concentration for each chemical as the source.

Example: Receptor Plume 1 = Total Area
MW1: Source for B, E & X; MW2: Source for T.
Include documentation for B & T only



Example: Receptor Plume 2 = Total Area



II. **Evaluate each receptor** identified by the receptor plume maps (for both groundwater or soil leaching to groundwater). The following process must be repeated for each applicable chemical as determined above.

A. Use the computer to develop a **receptor evaluation map** for each applicable chemical as determined by the receptor plume map above. For each applicable chemical, all of the receptors may be shown on one receptor evaluation map if it is legible. However, multiple receptor evaluation maps may be needed for each applicable chemical. Receptors may be grouped by pathway or by receptor type.

1. Identify one source for each chemical of concern to use for calculating the SSTL line and the simulation line. The source is the monitoring well with the maximum concentration. If there is more than one monitoring well with the same maximum concentration or if there is more than one monitoring well with free product, then you must calculate a source point and label it "S". The source is the average location for all the wells with free product or the average location for all the wells with the same maximum concentration. To calculate an average location, find the average of the x-coordinates of the source wells, find the average of the y-coordinates of the source wells, and plot the location of these two averages.

Example: if free product were found at two locations: (1,16) and (3, 18), the average x-coordinate would be (1+3)/2=2. The average y-coordinate would be (16+18)/2=17. The source would be plotted at the position: (2, 17).

2. For each receptor:
   a. Use the computer to draw an **SSTL line** on the map from the source to the receptor.
   b. Use the computer to draw an **SSTL line area**. This is a rectangle which includes the area 10 feet on either side of the SSTL line. (Refer to the following diagram.) It includes the receptor line.
   c. The **receptor line** is centered on the receptor, 20 feet long, perpendicular to the SSTL line.

d. Use the computer to plot **measured data**.

e. Use the computer to calculate the SSTL for the source.

f. Draw the **source line**, using the following directions.

1. If the source SSTL is less than the measured concentration at the source, draw a contour line around the source which represents the source SSTL value. This is the primary area. Draw a source line through the source, perpendicular to the SSTL line, and extending to the edge of the primary area. (Refer to the following diagram.)

2. If the source SSTL is greater than or equal to the measured concentration at the source, use the source width (Sw) as the length of the source line.

g. Draw the **secondary area**, by drawing lines to connect the source line and the receptor line, creating a trapezoid. (Refer to the following diagram.)

h. Determine which monitoring wells must be applied to that SSTL line. At a minimum, all monitoring wells within the secondary area must be evaluated for that SSTL line. If contamination has gone past the receptor, other monitoring wells should also be evaluated for that SSTL line. Enter the applicable monitoring wells into the computer.

i. Use the computer to calculate SSTL line values and simulation line values for each applicable monitoring well.

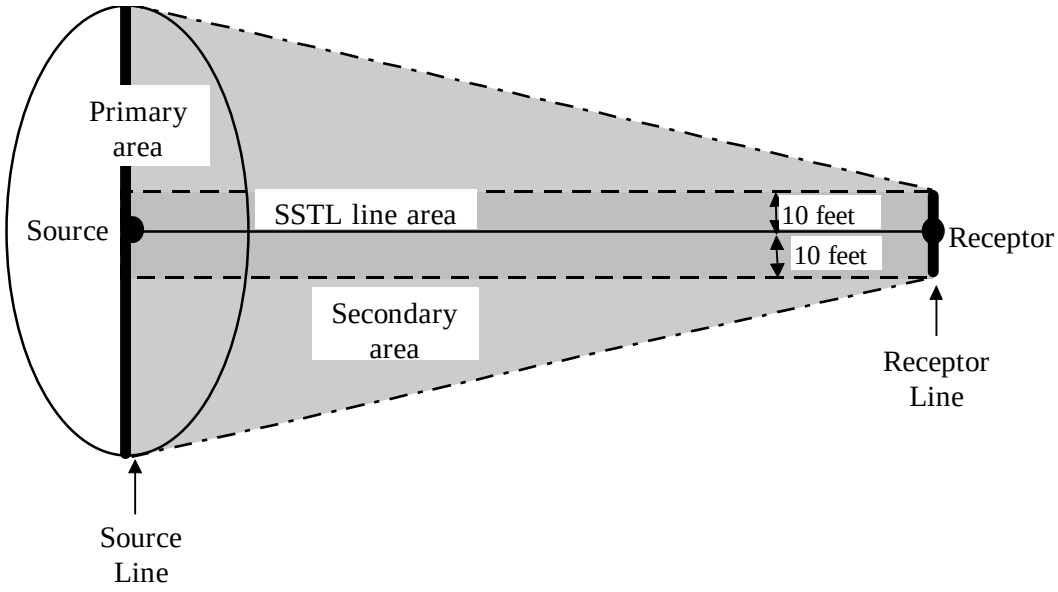
3. Plot the receptor evaluation map. It should include

a. the source

b. monitoring wells, labeled with measured data

c. for each receptor: the receptor, the SSTL line, SSTL line area, and the secondary area.

Diagram to Determine Which Monitoring Wells Must Be Compared to the SSTL Line



Primary area: where actual data exceeds the smallest source SSTL

SSTL line area: 10 feet on either side of the SSTL
(Monitoring wells must be in this area for exit monitoring unless justification is provided.)

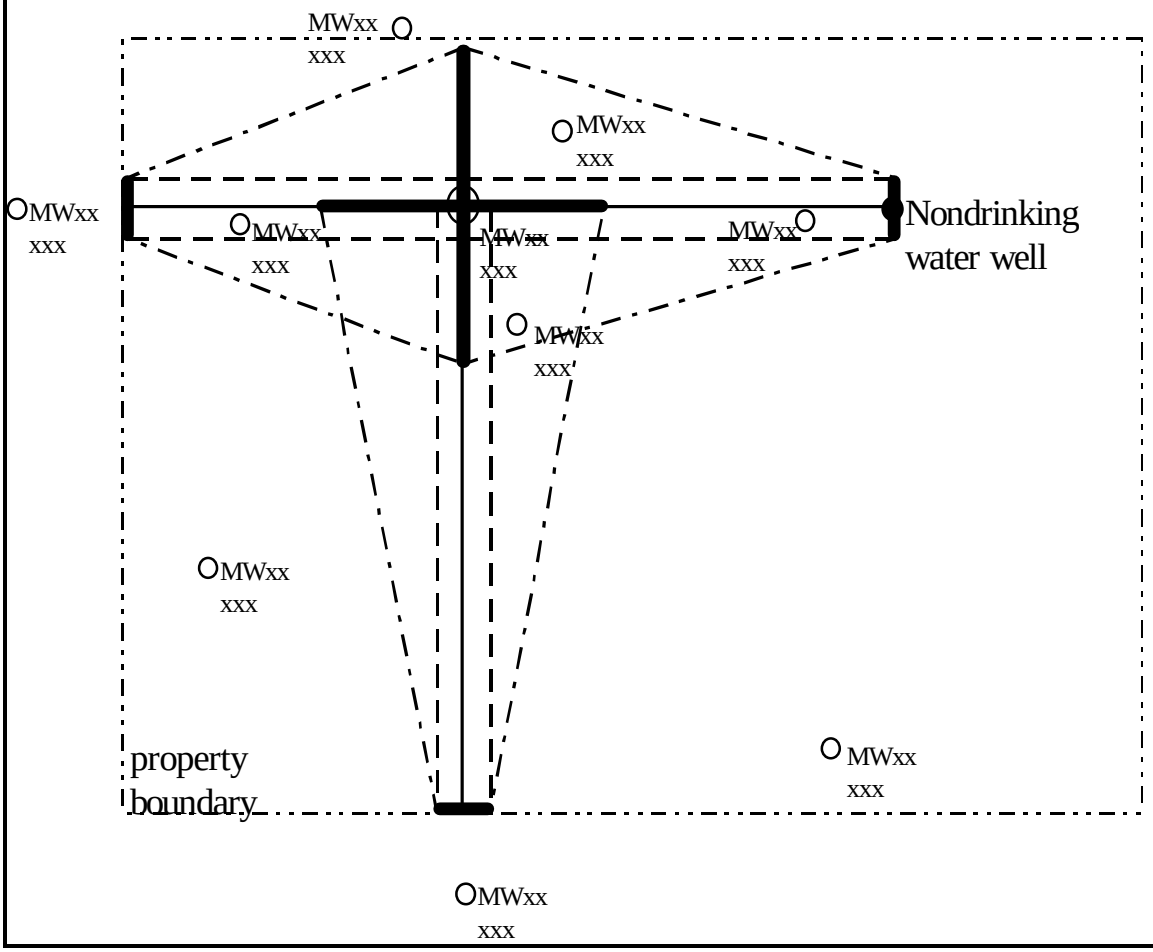
Secondary area: Box connecting the source line and the receptor line
(All monitoring wells in this area must be compared to the SSTL line. Monitoring wells must be in this area for exit monitoring for existing SCRs unless justification is provided.)

SSTL line: line from the source monitoring well to the receptor

Source line: line through the source, perpendicular to the SSTL line; with a length extending to the edge of the primary area

Receptor line: line with the receptor at its center, perpendicular to the SSTL line; with a length of 20 feet

Example:
Receptor Evaluation Plume—Groundwater Ingestion—Potential—Benzene
(Protected groundwater source, institutional control on the LUST property only.
All receptors within the receptor plume are shown: a nondrinking water well, and the property boundary in the two directions which were inside the receptor plume.)



B. **For each receptor:**

1. **Graph**: Use the computer to plot a graph for each receptor. This graph should show the location of all applicable monitoring wells, the receptor, the SSTL line with values calculated for each monitoring well, and the simulation line with values calculated for each monitoring well.

2. **SSTL Table:** Complete an SSTL Table for each receptor. (Refer to the example below.)
   a. "Receptor Type": choose one of the following:
      1. Groundwater ingestion—actual
      2. Groundwater ingestion—potential
      3. Groundwater vapor—confined space—residential
      4. Groundwater vapor—confined space—nonresidential
      5. Groundwater vapor—sanitary sewer—residential
      6. Groundwater vapor—sanitary sewer—nonresidential

7. Groundwater to plastic water line
8. Surface water

b. "Chemical": choose one of the chemicals of concern:

B = benzene
T = toluene
E = ethylbenzene
X = xylenes

TEH_d= Total Extractable Hydrocarbons for diesel

TEH_{wo}= Total Extractable Hydrocarbons for waste oil

c. "Location": list all applicable monitoring wells from the source to the receptor which are inside the secondary area for the SSTL (in order of increasing distance from the source) and any other monitoring wells which should be compared against this SSTL line. Also include the receptor.

d. For "Distance from Source", "Simulation Value", "Actual Data", and "SSTL Value": obtain data from the computer software.

e. Underline any SSTL line value or simulation value which is less than the measured concentration for that point.

f. Mark whether each monitoring well is located inside the SSTL Line Area or the Secondary Area, using the following symbols: Y = yes. — = no

g. Put an x in the appropriate box to identify whether the receptor is actual or potential.

h. Put an x in the appropriate box to identify the risk classification.

i. For any high or low risk receptors, identify the source, transition, and guard wells to be used for annual monitoring, using the abbreviations below. For sites converting from old SCR data, monitoring wells used for annual monitoring must be inside the secondary area unless justification is provided. Otherwise, monitoring wells used for annual monitoring must be inside the SSTL Line Area unless justification is provided.

S=source
T=transition
G=guard

j. Complete the boxes for "Comments/Justification".

Sample SSTL Table

Receptor Type:	Groundwater ingestion—actual						Chemical:	B
Location	Distance from Source (ft)	Simulation Value	Actual Data	SSTL Value	In SSTL Line Area		In Secondary	Monitor
MW18	0	17,500	17,500	2,201	Y		Y	S
MW20	25	6,395	4,280	804	-		Y	T
MW21	50	1,989	2	250	-		Y	G
City Well 13	240	40	-	5	Y		Y	
Receptor: City Well 13	X Actual	X High	Comments/Justification:					
	Potential	Low						
		NFA						

Soil Leaching		Soil@Soil Source	GW@Soil Source	Soil Leaching Risk Classification		
Source Location: MW18	Actual Data	15.00	17,500		x	High
	SSTL	2.92	2,201			Low
						NFA

3. **Tier 2 Receptor Summary**: Include information for each receptor in the table on pages 4-5. Refer to directions in section 6.1.4.

6.6.2 Soil Pathway Assessment

Soil Leaching to Groundwater. This pathway should be evaluated for each groundwater pathway as described in the above section on groundwater pathways. A soil SSTL must be calculated for each receptor and **included in the above SSTL tables**. The lowest soil SSTL is the target level which must be met for the whole site, and must be included in the Primary Area Table as described in section 6.7.3. A **graph** must be included for each receptor for which an SSTL line can be calculated. (If the source is a potential receptor, then the target level is applied at the source instead of calculating an SSTL.)

Include a **receptor evaluation map** which shows the actual soil plume, receptors and which areas exceed the lowest soil site-specific target level. A separate receptor evaluation map may be needed for each receptor type to make it legible. **Tier 2 Receptor Summary**: Include information for each receptor in the table on pages 4-5. Refer to directions in section 6.1.4.

Soil Vapor to Enclosed Space. Include a **Soil Vapor Map** for each chemical of concern. Each map should show the actual soil plume, receptors and which areas exceed the applicable target level. **Tier 2 Receptor Summary**: Include information for each receptor in the table on pages 4-5. Refer to directions in section 6.1.4.

Soil to Plastic Water Line. Include a **Soil to Plastic Water Line Map** for each chemical of concern. Each map should show the actual soil plume, receptors and which areas exceed the applicable target level. **Tier 2 Receptor Summary**: Include information for each receptor in the table on pages 4-5. Refer to directions in section 6.1.4.

6.7 Corrective Action

6.7.1 Description

For each pathway, briefly describe the receptors of concern, the lowest source target level and the recommended corrective actions. If any remediation is required or recommended, list the applicable receptors and briefly describe a recommended type of remediation.

6.7.2 Summary Corrective Action Maps

Develop two Summary Corrective Action Maps: one for soil and one for groundwater. It should include all high risk receptors for the whole site. Choose the chemical which appears to be most limiting for the site. If the map does not accurately depict areas which are recommended to require remediation, attach an additional map and explain in the description section above.

The Groundwater Summary Corrective Action Map should include:

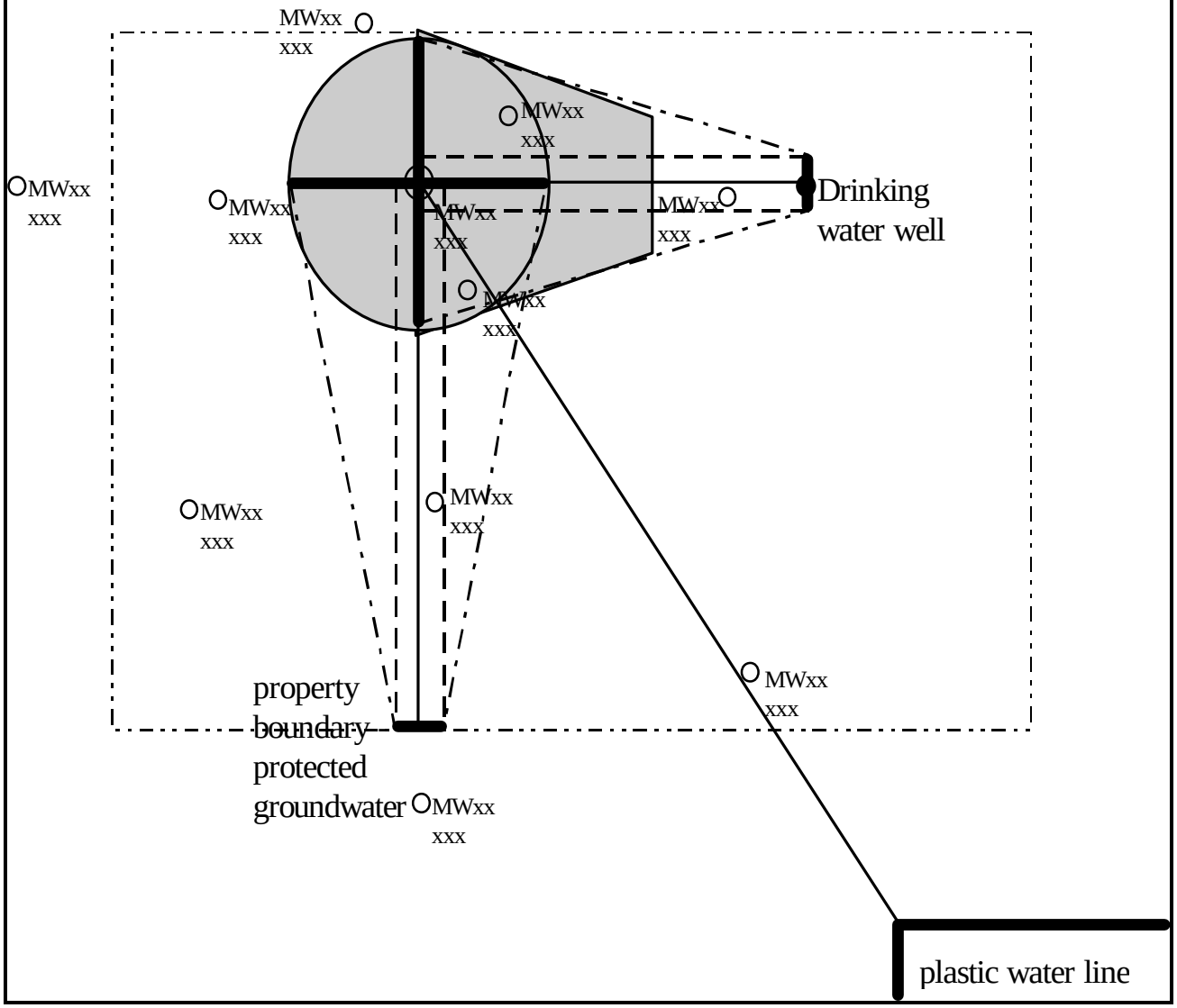
- SSTL line for all high risk receptors
- Primary area using the lowest SSTL for the whole site for any receptors with groundwater remediation recommended
- Secondary area for each receptor with soil or groundwater remediation recommended. Shade or otherwise mark the part of each secondary area where actual measured data exceeds the SSTL line.
- Monitoring wells: labeled with actual data. If soil or groundwater remediation is recommended, the associated monitoring wells must also be labeled with the lowest SSTL value for that point, and the associated receptor should also be labeled.

The Soil Summary Corrective Action Map should include:

- SSTL line for all high risk receptors for the soil leaching pathway
- All high risk receptors for the soil vapor and soil to plastic water line pathways
- Primary area using the lowest target level for the whole site for any receptors with soil remediation recommended

- Borings: labeled with actual data. If soil remediation is recommended, the associated boring must also be labeled with the lowest target level for that point.

Example:
Groundwater Summary Corrective Action Map
(All high risk receptors are shown. Institutional control on the LUST property only. Plastic water line will be removed. Shaded circle is the primary area in need of remediation. Shaded trapezoid is the only secondary area in need of remediation.)



6.7.3 Primary Area Table

Complete the Primary Area Table. The primary area is the area where concentrations exceed the smallest source SSTL for any receptors with soil or groundwater remediation recommended. There will be one primary area table for the whole site for each applicable chemical. Include the lowest source SSTL for the soil leaching pathway (which has soil remediation recommended) and the receptor for which this was calculated. Include the lowest source SSTL for any groundwater pathway (which has groundwater remediation recommended) and the receptor for which it was

calculated. List any monitoring wells which are inside the groundwater primary area and their actual measured concentration.

Sample Primary Area Table

Chemical: Benzene			Monitoring Wells in GW Primary Area	
	Soil	Groundwater	Location	Actual
Lowest Source SSTL	2.92	2,201	MW18	17,500
Receptor	City Well 13	City Well 13	MW20	4,280

6.8 Monitoring

6.8.1 Soil Gas Monitoring Plan

- Complete the Soil Gas Monitoring Plan Summary Table for all locations which require soil gas monitoring. Refer to section for more information on soil gas monitoring.
- Complete the Soil Gas Monitoring Comments/Justification section of the report. Explain which receptors are being monitored using soil gas measurements. Monitoring must be conducted annually at a minimum. If a more frequent rate is recommended, please explain in this section.
- Attach a Monitoring Map, and label locations for soil gas monitoring.

6.8.2 Groundwater Monitoring Plan

- Complete the **Groundwater Monitoring Plan Summary Table** for all high risk and low risk receptors for all pathways. One table should be completed for each applicable chemical identified by the receptor plume map. This table should list all monitoring wells required to be monitored annually. Start with the source well, and proceed in order of increasing distance from the source. Underline any SSTL values which are less than the actual measured value.

Sample Table:
Groundwater Monitoring Plan Summary Table--Chemical: Benzene

Location	Actual	SSTL	Receptor	Type	Frequency
MW18	17,500	2,201	City Well 13	S	Annual
		3,118	Sanitary sewer		
		4,453	City Well 12		
		4,684	H1		
		7,357	H2		
		11,033	H3		
		15,829	H4		
MW20	4,280	297	City Well 13	T	Annual
		804	City Well 13	T	
		1,627	City Well 12	T	
		4,487	H3	TG	
MW21	2	131	City Well 13	G	Annual
		250			
MW22	<1	214	City Well 12	G	Annual
MW7	269	1,700	H1	TG	Annual
		1,905			
MW19	216	3,518	H2	TG	Annual
		7,357	H4		
MW16	2,280	10,010	H5	TG	Annual

- Complete the Groundwater Monitoring Plan Comments/Justification section of the report.
- Include labeled locations for groundwater monitoring on the Monitoring Map.

6.9 Requirements for Maps and Appendices

Attach the following appendices to the end of the Tier 1 report form in the order listed. Title each appendix consistent with the bold print below.

6.9.1 Pathway Assessment Attachments

For pathway assessment attachments, follow the directions in the report checklist and sections 6.6 and 6.7.

1. Groundwater Ingestion—Actual.
2. Groundwater Ingestion—Potential.
3. Groundwater Vapor—Confined Space—Residential.
4. Groundwater Vapor—Confined Space—Nonresidential.
5. Groundwater Vapor—Sanitary Sewer—Residential.
6. Groundwater Vapor—Sanitary Sewer—Nonresidential.
7. Groundwater to Plastic Water Line.
8. Surface Water.
9. Soil Leaching to Groundwater.
- **9-1. Groundwater ingestion—actual**
- **9-2. Groundwater ingestion—potential**
- **9-3. Groundwater vapor—confined space—residential**
- **9-4. Groundwater vapor—confined space—nonresidential**
- **9-5. Groundwater vapor—sanitary sewer—residential**
- **9-6. Groundwater vapor—sanitary sewer—nonresidential**
- **9-7. Groundwater to plastic water line**
- **9-8. Surface water**

10. Soil Vapor to Enclosed Space.
11. Soil to Plastic Water Line.
12. Groundwater Summary Corrective Action Map
13. Soil Summary Corrective Action Map
14. Monitoring Plan Map

6.9.2 Other Maps

15. Landowner Map. Provide a scaled (scale 1 inch = 200 to 500 feet) vicinity map showing the site in relation to surrounding general features. It must show, but is not limited to the following pertinent general features: roads, waterways, property boundaries, and structures such as schools, hospitals, child care facilities and other buildings. Properties which meet the following criteria must be numbered on the Landowner Map and included in the Affected Property Owner Table in the report body: properties in any receptor plume which contains a receptor classified as high or low risk. (Refer to section 6.6 for further information on determining a receptor plume.) It must also show which areas are zoned for residential use.

16. Soil Contamination Plume Map. Provide a soil contamination plume map for each chemical of concern. The maps must depict the sample locations and soil analytical results used for the Tier 2 assessment, including data obtained from the Tier 1 field assessment, tank closures, site checks, or other investigations of the release at the site. If soil gas samples were collected, label the soil gas sample locations and indicate the soil gas analytical results.

Label contour lines with the different Tier 1 levels. If site-specific measurements are used to calculate target levels at the point of exposure for the vapor pathway, those target levels should be substituted for default target levels.

17. Groundwater Contamination Plume Map. Provide groundwater contamination plume map for each chemical of concern. The maps must depict the sample locations and analytical results used for the Tier 2 site assessment, including data obtained from the Tier 1 field assessment and other investigations of the release at the site.

Label contour lines with the different Tier 1 levels and other target levels at the point of exposure for different receptor types. For example, the groundwater contamination plume map for benzene should have contours labeled for the following:

5	290	1,540	3,080	4,780	9,550

If site-specific measurements are used to calculate target levels at the point of exposure for the vapor pathway, those target levels should be substituted for default target levels.

18. Groundwater Flow Direction Map. All wells at the site must be shown on the map. Wells constructed in different aquifers must be identified. Indicate the groundwater flow direction with an arrow. Groundwater contours and elevations at each data point used for contouring must be labeled on the map. Contours must be consistent with observed water elevations. An adequate number of water level measurements must be taken in each well to determine the static water level. Static water levels must be measured to the nearest 0.01 foot. Elevations used in the map must be measured on the same day.

19. Well Survey Map. Provide a site area map which identifies all groundwater wells including drinking water wells and non-drinking water wells within 1,000 feet of the source. Ensure the map is appropriately scaled.

20. Enclosed Space and Conduit Map. Provide a site area map which identifies all buildings (and whether they have basements), confined spaces, and conduits within any receptor plume for the vapor pathways. It should also identify the location of all plastic water lines within the receptor plume for the plastic water line pathways. Identify the enclosed space vapor sampling locations on the map. If the enclosed space is a residential property, provide a copy of the access agreement or identify the owner / tenant of the property and date of the survey. Number all enclosed spaces and conduits on the map to coordinate with "conduit number" from the Enclosed Space / Conduit Survey Table in the Tier 2 report form.

21. Surface Water Map. Provide a site map which identifies all surface water bodies within the surface water receptor plume. Ensure the map is appropriately scaled.

6.9.3 Other Appendices

22. Legal Description of Site. Provide a legal description of the site, using the township, range, and ¼, ¼, ¼, ¼ section.

23. Laboratory Data Sheets / Chromatograms. Provide copies of all laboratory data sheets including those for Total Dissolved Solids analyses, soil gas sample analyses, and indoor vapor sample analyses, if applicable. Provide copies of all Chain of Custody forms. Submit chromatograms and associated quantitation reports for the waste oil, diesel, and gasoline standards used by the laboratory to identify and quantify the field samples. The laboratory analytical report must state whether the sample tested matches the laboratory standard for waste oil, diesel or gasoline or that the sample cannot be reliably matched with any of these standards. Submit chromatograms for those soil and groundwater samples with the maximum concentrations of BTEX and TEH. Chromatograms for all other sample analyses should be obtained from the laboratory and made available to the department upon request. **Laboratory data sheets which have been previously submitted for the site do not need to be included in this appendix.**

24. Soil Boring Logs / Monitoring Well Construction Diagrams. Complete and attach DNR Form 542-1392 for each soil boring/monitoring well placed to investigate the petroleum release at this site, including boring logs and well construction diagrams for the Tier 1 assessment and any historic investigations. Indicate the casing and screen

material and screen slot size on each diagram. Include the static water level symbol "v" on the diagram for the water level at the time of sampling. At least one static water level measurement must be taken and indicated at the bottom of the log for each boring and well installed at the site. Each log must include vapor screening results and the soil sample(s) which was sent for laboratory analysis indicated. **Soil boring logs / monitoring well construction diagrams which have been previously submitted for the site do not need to be included in this appendix.**

25. Well Logs (drinking and non-drinking water wells). Provide copies of all available well logs for drinking water wells and non-drinking water wells and copies of DNR Form 542-1226 for wells plugged according to 567--Chapter 39.

26. Off-Site Contamination Source Support Data. Include any necessary documentation as described in section 6.4.

27. Tier 1 Selected Information. If a Tier 1 Report was not submitted previously, attach the following:

- pages 5, 6 and 10 of the report body
- Appendix 1- Topographic Site Map
- Appendix 2 - Site Plan
- Appendix 4 - Field Screening Map
- Appendix 11 - Tank Tightness Test Results
- Appendix 14 - Hydraulic Conductivity Measurements.

28. Corrective Action Documentation - *optional*
Declaration of Restrictive Covenants / Institutional Controls
Abandoned Water Well Plugging Record(s)
Water Supply (IDNR) / Designated County Agent Notification
Report of Plastic Water Line Removal and / or Relocation
Utility Company Notification
Sanitary Sewer Notification
Report of Excavation Activities and, if applicable, completed Land Application Notification Form.

6.10 Requirements for Computer Disk

Tier 1 Data. If the Tier 1 software was used to complete the Tier 1 analysis, a 3.5-inch high density disk which contains the site file(s) created from the software must be submitted. Label the file (and disk) with the LUST number.

Tier 2 Data. Submit a 3.5-inch high density disk which contains the site file(s) created from the Tier 2 software. Label the file (and disk) with the LUST number, followed by a 2. For example: 9LTZ002.